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DEFENSE SMALL BUSINESS INNOVATION RESEARCH PROGRAM  
(SBIR) FY 1985(U) DEPARTMENT OF DEFENSE WASHINGTON DC  
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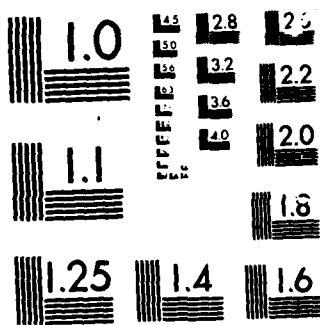
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# The Department of Defense

DoD Departments/Agency:



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of the  
Army



Department  
of the  
Navy



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Air Force



Defense  
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**Closing Date: 31 January 1985**

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## DEFENSE SMALL BUSINESS INNOVATION RESEARCH PROGRAM (SBIR) FY 1985

**PROGRAM SOLICITATION  
Number 85.1  
Small Business  
Innovation Research  
Program**

**Issue Date: 1 October 1984**

**U.S. Department of Defense**

**SBIR Program Office**

**Washington, DC 20301**

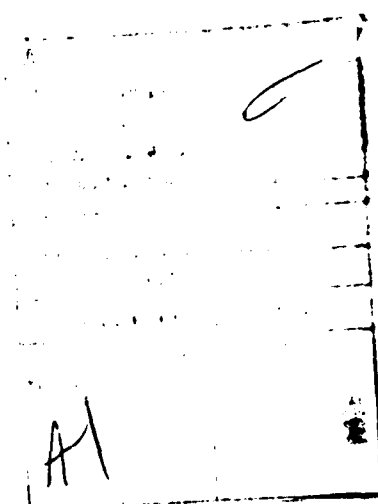
**Closing Date: 31 January 1985**



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# DOD PROGRAM SOLICITATION FOR SMALL BUSINESS INNOVATION RESEARCH

## 1.0 PROGRAM DESCRIPTION

### 1.1 Introduction

The Department of Defense (DOD) and its Components (Army, Navy, Air Force, Defense Advanced Research Project Agency (DARPA), and Defense Nuclear Agency (DNA), hereafter referred to as DOD Components) invite small business firms to submit proposals under this program solicitation entitled Small Business Innovation Research (SBIR). Firms with strong research and development capabilities in science or engineering in any of the topic areas described in Appendix D are encouraged to participate. Subject to the availability of funds, DOD and its Components will support high quality research or research and development proposals on innovative concepts related to important defense-related scientific or engineering problems.

Objectives of the DOD-SBIR Program include stimulating technological innovation in the private sector, strengthening the role of small business in meeting DOD research and development needs, fostering and encouraging participation by minority and disadvantaged persons in technological innovation, and increasing the commercial application of DOD-supported research or research and development results.

The Federal SBIR Program is mandated by Public Law (PL 97-219). The basic design of the DOD SBIR program is in accordance with the Small Business Administration (SBA) National Directive, #65-01.1. The DOD program presented in this solicitation brochure strives to encourage scientific and technical innovation in areas specifically identified by DOD components. The guidelines presented in the next section incorporate and exploit the flexibility of the SBA National Directive to encourage proposals based on scientific and technical approaches most likely to yield results important to DOD, rather than proposals focused on and built around a specific dollar level. In accordance with the National Directive, the DOD-SBIR Program is a three phase program as described in the text that follows. Results from prior years are as follows:

	Number of Topics	Proposals Received	Phase I Awards
<b>FY-83</b>			
Army	182	1246	96
Navy	131	944	67
Air Force	75	496	100
DARPA	8	128	12
DNA	10	88	8
	406	2902	283

	Number of Topics	Proposals Received	No. Selected for Phase I Negotiations
<b>FY-84</b>			
Army	111	761	81
Navy	147	847	99
Air Force	283	1212	166
DARPA	17	107	15
DNA	8	80	12
	566	3007	373

### 1.2 Three Phase Program

This program solicitation is issued pursuant to the Small Business Innovation Development Act of 1982, Public Law 97-219. Under Phase I, DOD Components anticipate making 350 awards during fiscal year 1985 to small businesses typically of one-half to one man-year effort over a period generally not to exceed six months, subject to negotiation. Phase I is to determine, insofar as possible, the scientific or technical merit and feasibility of ideas submitted under the SBIR program. Proposals should concentrate on that research or research and development which will significantly contribute to proving the scientific or technical feasibility of the proposed effort, the successful completion of which is a prerequisite for further DOD support in Phase II. The measures of Phase I success include evaluations of the extent to which Phase II results have the potential to yield a product of continuing importance to DOD.

Subsequent Phase II awards will be made only to firms on the basis of results from the Phase I effort, and the scientific and technical merit of the Phase II proposal. In FY 86 DOD anticipates making 100 Phase II awards from the Phase I awards in FY-85. Phase II awards will typically cover 2 to 5 man-years of effort over a period generally not to exceed 24 months, subject to negotiation. The number of Phase II awards will depend upon Phase I results and availability of funds. Phase II is the principal research or research and development effort; it will require a more comprehensive proposal which outlines the proposed effort in detail.

Under Phase III, non-Federal capital is expected to be used by the small business to pursue commercial applications of the research or development. Also, under Phase III, Federal agencies may award non SBIR-funded follow-on contracts for products or processes which meet the mission needs of those agencies. This solicitation is designed, in part, to provide incentives for the conversion of Federally-sponsored research and development innovation in the private sector. The Federal research and development can serve as both a technical and pre-venture capital base for ideas which may have commercial potential. Proposers are asked to consider whether the research and development they are proposing to DOD Components also has commercial possibilities, either for the proposed application or as a base for other applications. If it appears to have such potential, proposers are encouraged, on an optional basis, to obtain a contingent commitment for private follow-on funding to pursue further development of the commercial potential after the Government funded research and development phases.

Both Phase I and Phase II contracts may include a profit or fee.

*This solicitation is for Phase I proposals only.* Any proposal submitted under prior SBIR solicitations will *not* be considered under this solicitation; however, offerors who were *not* awarded a contract in response to a particular topic under prior SBIR solicitations are free to update or modify and submit the same or modified proposal if it is responsive to any of the topics listed in Appendix D hereto.

For Phase II, no separate solicitation will be issued as only those sources that were awarded Phase I contracts will be considered (see 6.3 and 7.1).

*DOD is not obligated to make any awards under either Phase I, II or III. DOD is not responsible for any monies expended by the proposer before award of any contract.*

### 1.3 Follow-on Funding

In addition to supporting scientific and engineering research and development, another important goal of the solicitation is the conversion of DOD supported research or research and development into technological innova-

tion by private firms. Therefore, on an optional basis, the DOD program includes an incentive for proposers to obtain a contingent commitment for private follow-on funding prior to Phase II to continue the innovation process where it is felt that the research or research and development also have commercial potential.

Proposers who feel that their research or research and development have the potential to meet market needs, in addition to meeting the DOD objectives, are encouraged to obtain non-Federal follow-on funding for Phase III to pursue commercial development. The commitment should be obtained during the course of Phase I performance. This commitment may be contingent on the DOD supported research or development meeting some specific technical objectives in Phase II which if met, would justify non-Federal funding to pursue further development for commercial purposes in Phase III. Note that when several Phase II proposals are evaluated as being of approximately equal merit, proposals that demonstrate such a commitment for follow-on funding will receive extra consideration during the evaluation process.

The recipient will be permitted to obtain commercial rights to any invention made in either Phase I or II, subject to the patent policies as stated in this solicitation (Section 7.6).

### 1.4 Eligibility and Limitations

Each proposer must qualify as a small business for research or research and development purposes as defined in Section 2.0 and certify to this on the cover sheet (Appendix A) of his proposal. In addition, a minimum of two-thirds of each SBIR project must be carried out by the proposing firm. For Phase II a minimum of one-half of the effort must be performed by the proposing firm. For both Phase I and II the primary employment of the principal investigator must be with the small business firm at the time of award and during the conduct of the proposed effort. Primary employment means that more than one-half of the principal investigator's time is spent with the small business. Deviations from these requirements must be approved in writing by the contracting officer.

For both Phase I and Phase II the research or research and development work must be performed by the small business concern in the United States. "United States" means the several states, the Territories and possessions of the United States, the Commonwealth of Puerto Rico, the Commonwealth of the Northern Mariana Islands, the Trust Territory of the Pacific Islands, and the District of Columbia.

Joint ventures and limited partnerships are permitted, provided the entity created qualifies as a small business in accordance with the Small Business Act, 15 USC 631, and the definition included in this solicitation.

**Conflicts of Interest.** Awards made to firms owned by or employing current or previous Federal Government employees could create conflicts of interest for those employees in violation of the Ethics in Government

Act of 1978 (P.L. 95-521, as amended by P.L. 96-19 and P.L. 96-28). Such proposers should contact the cognizant Ethics Counsellor of the DOD component for further guidance.

## 2.0 DEFINITIONS

The following definitions apply for the purposes of this solicitation:

### 2.1 Research or Research and Development —

Any activity which is (A) a systematic, intensive study directed toward greater knowledge or understanding of the subject studied; (B) a systematic study directed specifically toward applying new knowledge to meet a recognized need; or (C) a systematic application of knowledge toward the production of useful materials, devices, and systems or methods, including design, development, and improvement of prototypes and new processes to meet specific requirements. In DOD's R&D Program the definitions A, B, and C above correspond respectively as follows: (A) Basic Research, (B) Exploratory Development, and (C) Advanced Development or Engineering Development.

**2.2 Small Business**—A small business concern is one that, at the time of award of a Phase I or Phase II contract:

- (1) Is independently owned and operated and organized for profit, is not dominant in the field of operation in which it is proposing, and has its principal place of business located in the United States;
- (2) Is at least 51 percent owned, or in the case of a publicly owned business, at least 51 percent of its voting stock is owned by United States citizens or lawfully admitted permanent resident aliens;
- (3) Has, including its affiliates, a number of employees not exceeding 500, and meets the other regulatory requirements found in 13 CFR Part 121. Business concerns, other than investment companies licensed, or state development companies qualifying under the Small Business Investment Act of 1958, 15 U.S.C. 661, *et seq.*, are affiliates of one another when either directly or indirectly (A) one concern controls or has the power to control the other; or (B) a third party or parties controls or has the power to control both. Control can be exercised through common ownership, common management, and contractual relationships. The term

"affiliates" is defined in greater detail in 13 CFR 121.3-2(a). The term "number of employees" is defined in 13 CFR 121.3-2(t). Business concerns include, but are not limited to, any individual, partnership, corporation, joint venture, association or cooperative.

### 2.3 Minority and Disadvantaged Small Business

A small business that is:

- a. At least 51% owned by one or more minority and disadvantaged individuals; or, in the case of any publicly owned business, at least 51% of the voting stock of which is owned by one or more minority and disadvantaged individuals; and
- b. Whose management and daily business operations are controlled by one or more of such individuals.

While these individuals and small concerns will be required to compete for SBIR on the same basis as all other small business, attention will be given to a special outreach effort to ensure that minority and disadvantaged firms will have notice of this solicitation.

A minority and disadvantaged individual is defined as a member of any of the following groups: Black Americans; Hispanic Americans; Native Americans; Asian-Pacific Americans; or Asian-Indian Americans.

**2.4 Women-Owned Small Business** — A women-owned small business is that which is at least 51 percent owned by a woman or women who also control and operate it. "Control" in this context means exercising the power to make policy decisions. "Operate" in this context means being actively involved in the day-to-day management.

**2.5 Subcontract** — A subcontract is any agreement, other than one involving an employer-employee relationship, entered into by a Federal Government contract awardee calling for supplies or services required solely for the performance of the original contract.

## 3.0 TECHNICAL TOPICS

### 3.1 Phase I Topic List

Topics for each DOD Component are listed and numbered separately. Topics and topic descriptions are provided in Appendix D.

## 4.0 PHASE I PROPOSAL PREPARATION INSTRUCTIONS AND REQUIREMENTS

### 4.1 Proposal Requirements

A proposal to any DOD component under the SBIR program is to provide sufficient information to persuade the DOD Component that the proposed work represents a sound approach to the investigation of an important scientific or engineering problem and is worthy of support under the stated criteria.

Those responding to this solicitation should contact the Defense Technical Information Center (DTIC) for scientific and technical information assistance as described in Section 8.0. Background information available from DTIC on each of the topics listed in Appendix D can facilitate better informed decisions to bid or not to bid and may enhance the technical quality of a proposal by demonstrating more thorough knowledge of related work already completed or underway by DOD Components and others.

A proposal should be self-contained and written with care and thoroughness. Each proposal should be reviewed carefully by the offeror to ensure inclusion of all data essential for evaluation.

The scientific or technical merit of the proposed research or research and development is the primary concern for all research and development supported by the DOD. *A proposal must respond to only one of the topics listed in Appendix D.* An organization may submit separate proposals on different topics or different proposals on the same topic but each proposal must be limited to one topic. Where similar research and development is discussed in more than one topic description, the proposer should choose that topic the description of which appears most relevant to the proposer's technical concept.

The quality of the scientific or technical content of the proposal will be the principal basis upon which proposals will be evaluated. The proposed research or research and development must be responsive to the DOD program objectives, but can also serve as the base for technological innovation, new commercial products, process, or services which benefit the public.

If a proposal substantially the same as the one submitted in response to this solicitation has been previously funded

or is either funded by, pending with, or about to be submitted to another Federal agency or another DOD Component, or to the same DOD Component as a separate action, the proposer must so indicate and provide the information required by Section 4.4(12).

### 4.2 Proprietary Information

If information is provided which constitutes a trade secret, proprietary, commercial or financial information, confidential personal information, or data affecting the national security, it will be treated in confidence to the extent permitted by law, provided it is clearly marked in accordance with Section 7.7.

### 4.3 General Content

This solicitation is designed to reduce the investment of time and cost to small firms in preparing a formal proposal. Those who wish to respond must submit a direct, concise, and informative research or research and development proposal of *no more than 25 pages*, (no type smaller than elite on standard 8 1/2" x 11" paper with one (1) inch margins, 6 lines per inch) including proposal cover sheet (Appendix A), Project Summary (Appendix B) and Cost Proposal (Appendix C) and any enclosures and attachments. Promotional and non-project-related discussion is discouraged. *Cover all items listed below in Section 4.4 in the order given.* The space allocated to each will depend on the problem chosen and the principal investigator's approach. In the interest of equity, no additional attachments, appendices or references beyond the 25-page limitation will be considered in proposal evaluation, and proposals in excess of the 25-page limitation will not be considered for review or award.

The proposal must address the research or research and development proposed on the specific topic chosen. It is not necessary to provide a lengthy discourse on the commercial applications in the Phase I proposal except to discuss them briefly as described in Section 4.4, items 2 and 8.

#### 4.4 Phase I Proposal Format

All pages shall be consecutively numbered.

1. **Cover Sheet.** Photocopy and complete the form in Appendix A as page 1 of each copy of each proposal.

2. **Project Summary.** Photocopy and complete the form identified as Appendix B as page 2 of your proposal. The technical abstract should include a brief description of the project objectives, and description of the effort. Anticipated benefits and commercial applications of the proposed research or research and development should also be summarized in the space provided. The Project Summary of successful proposals will be submitted by DOD to SBA for publication and, therefore, should *not* contain proprietary or classified information.

3. **Identification and Significance of the Problem or Opportunity.** Define the specific technical problem or opportunity addressed and its importance. (Begin on page 3 of your proposal.)

4. **Phase I Technical Objectives.** Enumerate the specific objectives of the Phase I work, including the questions it will try to answer to determine the feasibility of the proposed approach.

5. **Phase I Work Plan.** This section must provide an explicit, detailed description of the Phase I approach. The plan should indicate not only what is planned but how and where the work will be carried out. Phase I effort should attempt to determine the technical feasibility of the proposed concept. The methods planned to achieve each objective or task should be discussed explicitly and in detail. This section should be substantial portion of the total proposal.

6. **Related Work.** Describe significant activities directly related to the proposed effort, including any conducted by the principal investigator, by the proposing firm, consultants, or others, how it interfaces with the proposed project, and any planned coordination with outside sources. The proposal must persuade reviewers of the proposer's awareness of the state-of-the-art in the specific topic.

7. **Relationship with Future Research or Research and Development.**

- a. State the anticipated results of the proposed approach if the project is successful.
- b. Discuss the significance of the Phase I effort in providing a foundation for Phase II research or research and development effort.

8. **Potential Post Applications.** Briefly describe:

- a. Whether and by what means the proposed project appears to have potential commercial application.

- b. Whether and by what means the proposed project appears to have potential use by the Federal Government.

9. **Key Personnel.** Identify key personnel who will be involved in the Phase I effort including information on directly related education and experience. A resume of the principal investigator, including a list of relevant publications (if any), must be included.

10. **Facilities/Equipment.** Describe available instrumentation and physical facilities necessary to carry out the Phase I effort. Items of equipment to be purchased (as detailed in Appendix C) shall be justified under this Section.

11. **Consultants.** Involvement of university or other consultants in the project may be appropriate. If such involvement is intended, it should be described in detail, and identified in Appendix C. A minimum of two-thirds of each SBIR project must be carried out by the proposing firm, unless otherwise approved in writing by the contracting officer.

12. **Prior, Current or Pending Support.** If a proposal submitted in response to this solicitation is substantially the same as another proposal that has been or is funded by, or is pending with another Federal Agency or DOD Component or to the same DOD Component, the proposer must provide the following information:

- a. The name and address of the Federal Agency(s) or DOD Component to which a proposal was submitted, or will be submitted, or from which an award is expected or has been received.
- b. Date of proposal submission or date of award.
- c. Title of proposal.
- d. Name and title of principal investigator for each proposal submitted or award received.
- e. Title, number, and date of solicitation(s) under which the proposal was submitted or will be submitted or under which award is expected or has been received.
- f. If award was received, state contract number.
- g. Specify the applicable topics for each pending SBIR proposal submitted or award received.

Note: If Section 4.4(12) does not apply, please state in the proposal "No prior, current or pending support for a similar proposal."

13. **Cost Proposal.** Complete the cost proposal in the form of Appendix C for the Phase I effort only. Under the direct labor category, list all key personnel by name as well as by number of hours dedicated to the project. (See also Section 7.8).

#### 4.5 Bindings

Do not use special bindings or covers. Staple the pages in the upper left hand corner of each proposal.

## 5.0 SUBMISSION OF PROPOSALS

Five (5) copies of each proposal or modification will be submitted, in a single package, as described below.

### 5.1 Address

Proposals (5 copies) and modifications thereof must be addressed to that DOD Component address which is identified for each topic in each Component's section of Appendix D to this solicitation.

One copy must be an original signed by the principal investigator *and* an official empowered to commit the proposer. Other copies may be photocopied.

The name and address of the offeror, the solicitation number and the topic number for the proposal must be clearly marked on the face of the envelope or wrapper.

Mailed or handcarried proposals must be delivered to the address indicated for each topic. Secure packaging is mandatory. The DOD Component cannot be responsible for the processing of proposals damaged in transit.

All copies of a proposal should be sent in the same package. Do not send separate "information" copies or several packages containing parts of the single proposal.

### 5.2 Deadline for Proposals

Deadline for receipt (5 copies) at the DOD Component is 2:00 p.m. local time, 31 January 1985. Any proposal received at the office designated in the solicitation after the exact time specified for receipt will not be considered unless it is received before an award is made, and: (1) it was sent by registered or certified mail not later than January 22, 1985; or (2) it was sent by mail and it is determined by the Government that the late receipt was due solely to mishandling by the Government after

receipt at the Government installation; or (3) it is the only proposal received.

The only acceptable evidence to establish (1) the date of mailing of a late received proposal sent either by registered mail or certified mail is the U.S. Postal Service postmark on the wrapper or on the original receipt from the U.S. Postal Service. If neither postmark shows a legible date, the proposal shall be deemed to have been mailed late. The term "postmark" means a printed, stamped, or otherwise placed impression (exclusive of a postage meter machine impression) that is readily identifiable without further action as having been supplied and affixed on the date of mailing by employees of the U.S. Postal Service. Therefore, offerors should request the postal clerk to place a hand cancellation bull's-eye "postmark" on both the receipt and the envelope or wrapper; (2) the time of receipt at the Government installation is the time-date stamp of such installation on the proposal wrapper or other documentary evidence of receipt maintained by the installation.

Proposals may be withdrawn by written notice or a telegram received at any time prior to award. Proposals may also be withdrawn in person by an offeror or his authorized representative, provided his identity is made known and he signs a receipt for the proposal prior to award. (NOTE: the term "telegram" includes mailgrams.)

Any modification or withdrawal of a proposal is subject to the same conditions outlined above. Any modification may not make the proposal longer than 25 pages. Notwithstanding the above, a late modification of an otherwise successful proposal which makes its terms more favorable to the Government will be considered at any time it is received and may be accepted.

## 6.0 METHOD OF SELECTION AND EVALUATION CRITERIA

### 6.1 Introduction

Phase I proposals will be evaluated on a competitive basis and will be considered to be binding for six (6) months from the date of closing of this solicitation unless offeror says otherwise. If selection has not been made prior to the proposal's expiration date, offerors will be requested as to whether or not they want to extend their proposal for an additional period of time. Proposals meeting stated solicitation requirements will be evaluated by scientists or engineers knowledgeable in the topic area. Proposals will be evaluated first on their relevance to the chosen topic. Those found to be relevant will then be evaluated using the criteria listed in Section 6.2. Final decisions will be made by the DOD Component based

upon these criteria and consideration of other factors, including possible duplication of other work, and program balance. A DOD Component may elect to fund several or none of the proposed approaches to the same topic. In the evaluation and handling of proposals, every effort will be made to protect the confidentiality of the proposal and any evaluations. There is no commitment by the DOD Components to make any awards on any topic, to make a specific number of awards or to be responsible for any monies expended by the proposer before award of a contract.

For proposals that have been selected for contract award, a government contracting officer will draw up an appropriate contract to be signed by both parties before work begins. Any negotiations that may be necessary will



be conducted between the offeror and the government contracting officer. It should be noted that only a duly appointed contracting officer has the authority to enter into a contract on behalf of the U.S. Government.

Phase II proposals will be subject to a technical review process similar to Phase I. Final decisions will be made by DOD Components based upon the scientific and technical evaluations and other factors, including a commitment for Phase III follow-on funding, the possible duplication with other research, development, program balance, budget limitations and the potential of a successful Phase II effort leading to a product of continuing interest to DOD.

## **6.2 Evaluation Criteria—Phase I**

The DOD components plan to select for award those proposals offering the best value to the Government with approximately equal consideration given to each of the following criteria, except for number one which will receive twice the weight of any other item:

- (1) The scientific/technical quality of the Phase I research or research and development proposal and its relevance to the topic description, with special emphasis on its innovation and originality.
- (2) Qualifications of the principal investigator, other key staff, and consultants, if any, and the adequacy of available or obtainable instrumentation and facilities.
- (3) Anticipated benefits of the research or research and development to the total DOD research and development effort.
- (4) Adequacy of the Phase I proposed effort to show progress toward demonstrating the feasibility of the concept.
- (5) Cost to the Government, including reasonableness of cost.

Where technical evaluations are essentially equal in merit, cost to the Government will be considered in determining the successful offeror.

Technical reviewers will base their conclusions only on information contained in the proposal. It cannot be assumed that reviewers are acquainted with the firm or key individuals or any referred-to experiments. Relevant supporting data such as journal articles, literature, including government publications, etc., should be identified in the proposal.

## **6.3 Evaluation Criteria—Phase II**

A Phase II proposal can be submitted only by a Phase I awardee. Phase II is *not* initiated by a solicitation.

Detailed instructions regarding Phase II proposal submission will be sent by DOD Components to all Phase I award winners. Listed below are some of the principles upon which those instructions can be expected to be based.

A Phase II proposal can be submitted at any time when progress attained under Phase I is deemed sufficient to justify the effort to be proposed for Phase II. (See Section 7.1.) It must contain enough information on progress accomplished under Phase I by the time of Phase II proposal submission to enable an evaluation of the project's promise if continued into Phase II. The Phase II proposal will be reviewed for overall merit based upon the criteria below. Each item will receive approximately equal weight, except for item one, which will receive twice the value of any other item:

- (1) The scientific/technical quality of the proposal, with special emphasis on its innovation and originality.
- (2) The qualifications of the principal investigator and other key personnel to carry out the proposed work.
- (3) Anticipated benefits of the research or development to the total DOD research and development effort.
- (4) Degree to which the Phase I objectives were met at the time of Phase II proposal submission.
- (5) The adequacy of the Phase II objectives to meet the problem or opportunity.
- (6) Cost to the Government, including reasonableness of cost.

Phase II proposal evaluations may include on-site evaluations by Government personnel of the Phase I effort.

The reasonableness of the proposed costs of the effort to be performed will be examined to determine those proposals that offer the best value to the Government.

In the case of proposals of approximately equal merit, the provision of a follow-on Phase III funding commitment for continued development from non-Federal funding sources will be a special consideration. The follow-on funding commitment must provide that a specific amount of Phase III funds will be made available to or by the small business and indicate the dates the funds will be made available. It must also contain specific technical objectives which, if achieved in Phase II, will make the commitment exercisable by the small business. The terms cannot be contingent upon the obtaining of a patent due to the length of time this process requires. The funding commitment shall be submitted with the Phase II proposal.

## 7.0 CONTRACTUAL CONSIDERATIONS

### 7.1 Awards

The number of Phase I awards will be consistent with the agency's RDT&E budget, the number of anticipated awards for interim period Phase I modifications, and Phase II contracts.

No Phase I contracts will be awarded until all qualified proposals (received in accordance with section 5.2) on a specific topic have been evaluated. Phase I selectees are expected to be notified no later than July 31, 1985. The names of those firms receiving awards will be announced.

The number of the Phase I awardees that will receive Phase II awards will depend upon the results of the Phase I efforts and the availability of funds. Phase II is to further develop ideas explored under Phase I. Specific instructions for the preparation of Phase II proposals will be sent to Phase I awardees by the DOD Components. Phase II proposers who wish to maintain project continuity must submit proposals no later than 30 days prior to the expiration date of the Phase I contract and must identify in their proposal the work to be performed for the first four months of the Phase II work and the costs associated therewith. These Phase II proposers may be issued a modification to the Phase I contract, at the discretion of the Government, covering an interim period not to exceed four months for preliminary Phase II work while the total Phase II proposal is being evaluated. This modification would normally become effective at the completion of Phase I or as soon thereafter as possible. Funding, scope of work, and length of performance for this interim period will be subject to negotiations. Issuance of a contract modification for the interim period does not commit the Government to award a Phase II contract.

Offerors for Phase II work who do not elect to submit a proposal 30 days prior to the expiration date of the Phase I contract, have the option to submit a proposal after the completion of the Phase I contract. The final date for receipt of a Phase II proposal will be not later than 60 calendar days after the completion of the Phase I contract.

The period of performance under Phase II will depend upon the scope of the effort, but generally will not exceed 24 months. Phase II award decisions will be based upon evaluation of progress attained under Phase I and of the Phase II proposal. Phase II awards will typically cover 2 to 5 man-years effort, depending upon the scope of research or development.

### 7.2 Reports

Six copies of a final report on the Phase I project must be submitted to the DOD Component in accordance with the negotiated delivery schedule. This will normally be

within thirty days after completion of the Phase I effort. The final report shall include a single-page project summary as the first page identifying the purpose of the work, a brief description of the work carried out, the findings or results, and potential applications of the effort. The summary may be published by DOD and therefore must *not* contain proprietary or classified information. The balance of the report should indicate in detail the project objectives, work carried out, results obtained, and estimates of technical feasibility.

To avoid duplication of effort, language used to report Phase I progress in a Phase II proposal, if submitted, may be used verbatim in the final report with changes only to accommodate results obtained after Phase II proposal submission, and modifications required to integrate the final report into a self-contained, comprehensive and logically structured document.

### 7.3 Payment Schedule

Payments will be made in accordance with a payment schedule agreed to by the Contracting Officer. Requests for progress payments or advance payments based upon demonstrated need will be considered. The offeror shall include his cash flow requirements as part of the cost proposal submission for Phase I.

### 7.4 Technical Data

Rights in technical data, including software, developed under the terms of any contract results from proposals submitted in response to this solicitation shall remain with the contractor, except that the Government shall have the limited right to use such data for Government purposes and shall not release such data outside the Government without permission of the contractor for a period of two years from completion of the project from which the data was generated unless the data has already been released to the general public. However, effective at the conclusion of the two-year period, the Government shall retain a royalty-free license for Government use of any technical data delivered under an SBIR funding agreement whether patented or not.

### 7.5 Copyrights

With prior written permission of the contracting officer, the awardee normally may copyright (consistent with appropriate national security considerations, if any) material developed with DOD support. DOD receives a royalty-free license for the Federal Government and requires that each publication contain an appropriate acknowledgement and disclaimer statement.

## 7.6 Patents

Small business firms normally may retain the principal worldwide patent rights to any invention developed with Government support. The Government receives a royalty-free license for its use, reserves the right to require the patentholder to license others in certain limited circumstances, and requires that anyone exclusively licensed to sell the invention in the United States must normally manufacture it domestically. To the extent authorized by 35 USC 205, the Government will not make public any information disclosing a Government-supported invention for a two-year period to allow the awardee a reasonable time to pursue a patent.

## 7.7 Markings of Proprietary or Classified Proposal Information

The proposal submitted in response to this solicitation may contain technical and other data, including trade secrets and/or privileged or confidential commercial or financial information, which the proposer does not want disclosed to the public or used by the Government for any purpose other than proposal evaluation.

Information contained in unsuccessful proposals will remain the property of the proposer. The government may, however, retain copies of all proposals. Public release of information in any proposal submitted will be subject to existing statutory and regulatory requirements.

If proprietary information is provided by a proposer in a proposal which constitutes a trade secret, proprietary commercial or financial information, confidential personal information or data affecting the national security, it will be treated in confidence, to the extent permitted by law, provided this information is clearly marked by the proposer with the term "confidential proprietary information" and provided that following legend appears on the title page of the proposal:

"For any purpose other than to evaluate the proposal, this data shall not be disclosed outside the government and shall not be duplicated, used, or disclosed in whole or in part, provided that if a contract is awarded to this proposer as a result of or in connection with the submission of this data, the government shall have the right to duplicate, use, or disclose the data to the extent provided in the contract. This restriction does not limit the government's right to use information contained in the data if it is obtained from another source without restriction. The data subject to this restriction is contained in pages \_\_\_\_\_ of this proposal."

Any other legend may be unacceptable to the government and may constitute grounds for removing the proposal from further consideration and without assuming any liability for inadvertent disclosure. The government

will limit dissemination of properly marked information to within official channels.

In addition, each page of the proposal containing proprietary data which the proposer wishes to restrict must be marked with the following legend:

"Use or disclosure of the proposal data on lines specifically identified by asterisk (\*) are subject to the restriction on the cover page of this proposal."

The government assumes no liability for disclosure or use of unmarked data and may use or disclose such data for any purpose.

In the event properly marked data contained in a proposal in response to this solicitation is requested pursuant to the Freedom of Information Act, 5 USC 552, the proposer will be advised of such request and prior to such release of information he will be requested to expeditiously submit to the DOD Component a detailed listing of all information in his proposal which he believes to be exempt from disclosure under the Act. Such action and cooperation on the part of the proposer will ensure that any information released by the DOD Component pursuant to the Act is properly determined.

Those proposers that have classified facility clearance may submit classified material with their proposal. Any classified material shall be marked and handled in accordance with applicable regulations. Arbitrary and unwarranted use of this restriction is discouraged. Offerors must follow the Industrial Security Manual for Safeguarding Classified Information (DOD 5220.22M) procedures for marking and handling classified material.

## 7.8 Cost Proposal

A firm fixed price or cost plus fixed fee Phase I proposal must be submitted in detail in the format shown in Appendix C. Some items of Appendix C may not apply to the proposed project. If such is the case, there is no need to provide information for each and every item. What matters is that enough information be provided to allow the DOD Component to understand how the proposer plans to use the requested funds if the contract is awarded. Both Phase I and II contracts may include a profit or fee.

**1. Special Tooling and Test Equipment, and Material.** Special tooling and test equipment and material cost may be included under Phases I and II. The inclusion of equipment and material will be carefully reviewed relative to need and appropriateness for the work proposed.

The purchase of special tooling and test equipment must, in the opinion of the Contracting Officer, be advantageous to the Government and should be related directly to the specific topic. They may include such items as innovative instrumentation and/or automatic test equipment. Title to property furnished by the Government or

acquired with Government funds, will be vested with the DOD Component, unless it is determined that transfer of title to the contractor would be more cost effective than recovery of the equipment by the DOD Component.

2. **Travel.** Cost for travel funds must be justified and related to the needs of the project.

3. **Cost-Sharing.** Cost-sharing is permitted for proposals under this solicitation; however, cost-sharing is not required nor will it be an evaluation factor in the consideration of a proposal.

## **7.9 Contractor Commitments**

Upon award of a contract, the contractor will be required to make certain legal commitments through acceptance of government contract clauses in the Phase I contract. The outline that follows is illustrative of the types of provisions that will be included in the Phase I contract. This is not a complete list of provisions to be included in Phase I contracts, nor does it contain specific wording of these clauses. Copies of complete general provisions will be made available prior to award.

1. **Standards of Work.** Work performed under the contract must conform to high professional standards.

2. **Inspection.** Work performed under the contract is subject to Government inspection and evaluation at all reasonable times.

3. **Examination of Records.** The Comptroller General (or a fully authorized representative) shall have the right to examine any directly pertinent records of the contractor involving transactions related to this contract.

4. **Default.** The Government may terminate the contract if the contractor fails to perform the work contracted.

5. **Termination for Convenience.** The contract may be terminated at any time by the Government if it deems termination to be in its best interest, in which case the contractor will be compensated for work performed and for reasonable termination costs.

6. **Disputes.** Any dispute concerning the contract which cannot be resolved by agreement shall be decided by the contracting officer with right of appeal.

7. **Contract Work Hours.** The contractor may not require an employee to work more than eight hours a day or forty hours a week unless the employee is compensated accordingly (that is, receives overtime pay).

8. **Equal Opportunity.** The contractor will not discriminate against any employee or applicant for employment because of race, color, religion, sex, or national origin.

9. **Affirmative Action for Veterans.** The contractor will not discriminate against any employee or applicant for employment because he or she is a disabled veteran or veteran of the Vietnam era.

10. **Affirmative Action for Handicapped.** The contractor will not discriminate against any employee or applicant for employment because he or she is physically or mentally handicapped.

11. **Officials Not to Benefit.** No member of or delegate to Congress shall benefit from the contract.

12. **Covenant Against Contingent Fees.** No person or agency has been employed to solicit or secure the contract upon an understanding for compensation except bonafide employees or commercial agencies maintained by the contractor for the purpose of securing business.

13. **Gratuities.** The contract may be terminated by the Government if any gratuities have been offered to any representative of the Government to secure the contract.

14. **Patent Infringement.** The contractor shall report each notice or claim of patent infringement based on the performance of the contract.

15. **Military Security Requirements.** The Contractor shall safeguard any classified information associated with the contracted work in accordance with applicable regulations.

## **8.0 SCIENTIFIC AND TECHNICAL INFORMATION ASSISTANCE**

### **8.1 DOD Technical Information Services Available**

Recognizing that small businesses may not have strong technical information service support, the Defense Technical Information Center (DTIC) is prepared to give special attention to the needs of DOD SBIR Program participants.

Many of the 1500 small business requestors who responded to FY-83 and FY-84 DOD SBIR Program

solicitations believe that the scientific and technical information which DTIC provided enabled them to make better informed bid/no bid decisions and prepare technically stronger proposals. People responding to this solicitation are encouraged to contact DTIC for bibliographies of technical reports that have resulted from prior DOD-funded R&D, for copies of the technical reports which are cited in these bibliographies, and for information about DOD-sponsored work currently in progress in their proposal topic areas.

DTIC is the central source of scientific and technical information resulting from and describing R&D projects that are funded by DOD. DTIC searches this information for registered requesters. Reasonable quantities of paper or microfiche copies of requested documents are available for SBIR Program proposal preparation.

DTIC will also provide referrals to DOD-sponsored Information Analysis Centers (IACs) where specialists in mission areas assigned to these IACs perform informational and consultative services.

DTIC assistance will include references to other sources of scientific and technical information needed to prepare SBIR Program proposals to DOD. Call or visit DTIC at the following location which is most convenient to you.

All written communications with DTIC must be made to the Cameron Station, Alexandria, VA, address.

Defense Technical Information Center  
ATTN: DTIC-SBIR  
Building 5, Cameron Station  
Alexandria, VA 22314  
(800) 368-5211 (Toll free)  
(202) 274-6902 (Commercial for Virginia, Alaska and Hawaii)

DTIC Boston On-Line Service Facility  
AFGL Research Library/SULL  
Building 1103, Hanscom AFB  
Bedford, MA 01731  
(617) 861-2413

DTIC Los Angeles On-Line Service Facility  
Defense Contract Administration Services Region  
11099 South LaCienega Boulevard  
Los Angeles, CA 90045  
(213) 643-1108

Use reference A at the back of this solicitation to request background bibliographies and descriptions of work in progress related to those topic areas which you plan to pursue under this solicitation. DTIC will return the material you request, annotated with a temporary User Code. This User Code is to be used by you when requesting additional information or when ordering documents cited in a bibliography until the solicitation closing date.

Because solicitation response time is limited, submit your requests for DTIC's information services as soon as possible.

## **8.2 Other Technical Assistance Program**

The Small Business Administration, Office of Innovation, Research and Technology, in cooperation with the University of Connecticut and the University of Southern California, will provide a fast-reaction technology information service for small businesses interested in participating in the Small Business Innovation Research (SBIR) program. The service provides, within five days,

state-of-the-art information useful in preparing SBIR proposals or in guiding SBIR research efforts. The output is a comprehensive bibliography (often with abstracts) derived from a computerized search of a wide variety of data bases. The cost of this service to small businesses is \$125.00 per inquiry. SBA will provide supplemental funding to offset actual costs which are significantly higher. Documents can also be ordered for an additional fee and can typically be delivered within three weeks. To obtain this service or additional information, please contact one of the following university-based centers:

For small firms in the states of Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, Nevada, North Dakota, Oregon, South Dakota, Utah, Washington, and Wyoming:

University of Southern California  
Western Research Applications Center (WESRAC)  
3716 S. Hope Street #200  
Los Angeles, California 90007  
(213) 743-6132

For firms in all other states:

University of Connecticut  
New England Research Application Center  
(NERAC)  
Mansfield Professional Park  
Storrs, Connecticut 06268  
(203) 486-4586

Other sources also provide technology search and/or document services and can be contacted directly for service and cost information. These include:

National Technical  
Information Service  
5285 Port Royal Road  
Springfield, VA 22161  
(703) 487-4600

Aerospace Research  
Applications Center  
P.O. Box 647  
Indianapolis, Indiana 46223  
(317) 264-4644

Kerr Industrial  
Applications Center  
Southeastern Oklahoma  
State University  
Durant, Oklahoma 74701  
(405) 924-6822

North Carolina Science and  
Technology Research Center  
Post Office Box 12235  
Research Triangle Park,  
North Carolina 27709  
(919) 549-0671

NASA Industrial Applications Center  
701 LIS Building  
University of Pittsburgh  
Pittsburgh, Pennsylvania 15260  
(412) 624-5211

NASA/UK Technology  
University of Kentucky  
109 Kinkead Hall  
Lexington, Kentucky 40506  
(606) 257-6322

NASA/Florida State Technology  
Applications Center  
State University System of Florida  
500 Weil Hall  
Gainesville, Florida 32611  
(904) 392-6626

## **9.0 CONTACT WITH DOD**

### **9.1 Oral Communications**

Oral communications with DOD Components regarding this solicitation during the Phase I proposal preparation period are prohibited for reasons of competitive fairness, with the exceptions as stated in Sections 1.4, 8.0 and 9.7.

### **9.2 Questions Pertaining to This Solicitation**

Questions pertaining to this solicitation should be addressed in writing to the address listed at the beginning of each DOD Component listing of topics (See Appendix D). No telephone requests will be accepted except as stated in Section 9.1.

### **9.3 Requests for Additional Copies of This Solicitation**

Additional copies of this solicitation can be ordered from the Defense Technical Information Center, Attn: DTIC/SBIR, Building 5, Cameron Station, Alexandria, Virginia 22314; (telephone (800) 368-5211 (toll free))/(202) 274-6902 (commercial for Virginia, Alaska and Hawaii).

### **9.4 Information on Proposal Status**

Evaluation of proposals and award of contracts will be expedited, but no information on proposal status will be available until the final selection is made. However, contracting officers may contact any and all qualified proposers prior to contract award.

### **9.5 Debriefing of Unsuccessful Offerors**

After final award decisions have been announced a debriefing may be provided to unsuccessful offerors, on their proposals only, upon written request.

### **9.6 Correspondence Relating to Proposals**

All correspondence relating to proposals should cite the SBIR solicitation number, specific topic number and be addressed to the DOD Component whose address is associated with each topic number.

### **9.7 Counseling Assistance Available**

Small business firms interested in participating in the SBIR Program may seek general administrative guidance from small and disadvantaged business utilization specialists located in various Defense Contract Administration Services (DCAS) activities throughout continental United States. These specialists are available to discuss general administrative requirements to facilitate the submission of proposals and ease the entry of the small high technology business into the Department of Defense marketplace. The small and disadvantaged business utilization specialists are expressly prohibited from taking any action which would give an offeror an unfair advantage over others, such as discussing or explaining the technical requirements of the solicitation, writing or discussing technical or cost proposals, estimating cost or any other actions which are the offerors responsibility as outlined in this solicitation. (See reference C at the end of this solicitation for a complete listing, with telephone numbers, of Small and Disadvantaged Business Utilization Specialists assigned to DCAS Activities.)

### **9.8 Notifications of Proposal Receipt**

Proposers desiring notification of receipt of their proposal must complete and include a self addressed and stamped envelope and a copy of the notification form (reference B) in the back of this brochure. If multiple proposals are submitted, a separate form and envelope is required for each. Notification of receipt of a proposal by the government does not by itself constitute a determination that the proposal was received on time or not. The determination of timeliness is solely governed by the criteria set forth in Section 5.2.

## **10.0 ADDITIONAL INFORMATION**

### **10.1**

This Program Solicitation is intended for informational purposes and reflects current planning. If there is any inconsistency between the information contained herein and the terms of any resulting SBIR contract, the terms of the contract are controlling.

### **10.2**

Before award of an SBIR contract, the Government may request the proposer to submit certain organizational, management, personnel and financial information to confirm responsibility of the proposer.

### **10.3**

The Government is not responsible for any monies expended by the proposer before award of any contract.

### **10.4**

This Program Solicitation is not an offer by the Government and does not obligate the Government to make any

specific number of awards. Also, awards under this program are contingent upon the availability of funds.

### **10.5**

The SBIR program is not a substitute for existing unsolicited proposal mechanisms. Unsolicited proposals will not be accepted under the SBIR program in either Phase I or Phase II.

### **10.6**

If an award is made pursuant to a proposal submitted under this Program Solicitation, the contractor will be required to certify that he or she has not previously been, nor is currently being, paid for essentially equivalent work by an agency of the Federal Government.

### **10.7**

If classified work is proposed or classified information is involved, the Offeror to this solicitation must have, or obtain, security clearance in accordance with the Industrial Security Manual for Safeguarding Classified Information (DOD 5220.22M).

Appendix A  
Solicitation No. 85.1  
Proposal Cover Sheet

**DEFENSE SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM**

Topic Number: \_\_\_\_\_ ☐ Army ☐ Navy ☐ Air Force ☐ DARPA ☐ DNA

Proposal Title: \_\_\_\_\_  
\_\_\_\_\_

Submitted By: Firm \_\_\_\_\_

Address \_\_\_\_\_

City \_\_\_\_\_ State \_\_\_\_\_ Zip Code \_\_\_\_\_

Submitted to: (Activity identified with the topic) \_\_\_\_\_

Address \_\_\_\_\_

City \_\_\_\_\_ State \_\_\_\_\_ Zip Code \_\_\_\_\_

**Small Business Certification:**

The above firm certifies it is a small business firm and meets the definition stated in the Small Business Act 15 U.S.C. 631 and in the Definition Section of the Program Solicitation.

"The above firm certifies that it \_\_\_\_\_ does \_\_\_\_\_ does not qualify as a minority or disadvantaged small business as defined in the Definition Section of the Program Announcement."

The above firm certifies that it qualifies as a woman-owned small business firm :

Yes \_\_\_\_\_ No \_\_\_\_\_

**Disclosure permission statement as follows:**

All data on Appendix A is releasable information. All data on Appendix B, for an awarded contract, is also releasable.

"Will you permit the Government to disclose the information on Appendix B, if your proposal does not result in an award, to any party that may be interested in contacting you for further information or possible investment?"

Yes \_\_\_\_\_ No \_\_\_\_\_

Number of employees including all affiliates (average for preceding 12 months): \_\_\_\_\_

Proposed Cost (Phase I): \_\_\_\_\_

Proposed Duration: \_\_\_\_\_ months (not to exceed six months).

Project Manager/Principal Investigator

Corporate Official (Business)

Name \_\_\_\_\_ Name \_\_\_\_\_

Title \_\_\_\_\_ Title \_\_\_\_\_

Signature \_\_\_\_\_ Signature \_\_\_\_\_

Date \_\_\_\_\_ Date \_\_\_\_\_

Telephone \_\_\_\_\_ Telephone \_\_\_\_\_

For any purpose other than to evaluate the proposal, this data shall not be disclosed outside the government and shall not be duplicated, used, or disclosed in whole or in part, provided that if a funding agreement is awarded to this proposer as a result of or in connection with the submission of this data, the Government shall have the right to duplicate, use, or disclose the data to the extent provided in the funding agreement. This restriction does not limit the Government's right to use information contained in the data if it is obtained from another source without restriction. The data subject to this restriction is contained in pages \_\_\_\_\_ of this proposal.



**U.S. DEPARTMENT OF DEFENSE**

**SMALL BUSINESS INNOVATION RESEARCH PROGRAM**  
**PHASE 1 – FY 1985**  
**PROJECT SUMMARY**

Topic No. \_\_\_\_\_

Military Department/Agency \_\_\_\_\_

Name and Address of Proposer

Name and Title of Principal Investigator

Proposer's Title\*

Technical Abstract\* (Limit your abstract to 200 words with no classified or proprietary information/data.)

Anticipated Benefits/Potential Commercial Applications of the Research or Development

List a maximum of 8 Key Words that describe the Project.

\*Nothing on this page is classified or proprietary information/data

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# APPENDIX C

## COST PROPOSAL

### DEFENSE SMALL BUSINESS INNOVATION RESEARCH PROGRAM (SBIR)

#### Background:

The following items, as appropriate, should be included in proposals responsive to the DOD Solicitation Brochure. As an alternative to the following items, the Standard Form 1411 (Department of Defense Contract Pricing Proposal) may be used.

#### Cost Breakdown Items (in this order, as appropriate):

1. Name of offeror
2. Home office address
3. Location where work will be performed
4. Title of proposed effort
5. Topic number and topic title from DOD Solicitation Brochure
6. Total Dollar amount of the proposal (dollars)
7. Direct material costs
  - a. Purchased parts (dollars)
  - b. Subcontracted items (dollars)
  - c. Other
    - (1) Raw material (dollars)
    - (2) Your standard commercial items (dollars)
    - (3) Interdivisional transfers (at other than cost) (dollars)
  - d. Total direct material (dollars)
8. Material overhead (rate \_\_\_\_\_%)  $\times$  total direct material = dollars
9. Direct labor (specify)
  - a. Type of labor, estimated hours, rate per hour and dollar cost for each type.
  - b. Total estimated direct labor (dollars)
10. Labor overhead (specify company cost center)
  - a. For each cost center identify overhead rate, the hour base and dollar cost.
  - b. Total estimated labor overhead (dollars)
11. Special testing (include field work at Government installations)
  - a. Provide dollar cost for each item of special testing
  - b. Estimated total special testing (dollars)
12. Special equipment
  - a. If direct charge, specify each item and cost of each
  - b. Estimated total special equipment (dollars)
13. Travel (if direct charge)
  - a. Transportation (detailed breakdown and dollars)
  - b. Per Diem or subsistence (details and dollars)
  - c. Estimated total travel (dollars)
14. Consultants
  - a. Identify each, with purpose, and dollar rates
  - b. Total estimated consultants costs (dollars)
15. Other direct costs (specify)
  - a. Total estimated direct cost and overhead (dollars)
16. General and administrative expense
  - a. Percentage rate applied
  - b. Total estimated cost of G&A expense (dollars)
17. Royalties (specify)
  - a. Estimated cost (dollars)
18. Fee or profit (dollars)
19. Total estimate cost and fee or profit (dollars)
20. The cost breakdown portion of a proposal must be signed by a responsible official, and the person signing must have typed name and title and date of signature must be indicated.
21. On the following items offeror must provide a yes or no answer to each question.
  - a. Has any executive agency of the United States Government performed any review of your accounts or records in connection with any other government prime contract or subcontract within the past twelve months? If yes, provide the name and address of the reviewing office, name of the individual and telephone/extension.
  - b. Will you require the use of any government property in the performance of this proposal? If yes, identify.
  - c. Do you require government contract financing to perform this proposed contract? If yes, then specify type as advanced payments or progress payments.
22. Type of contract proposed, either cost-plus-fixed-fee or firm-fixed price.

ARMY SMALL BUSINESS INNOVATION RESEARCH PROGRAM  
SUBMITTING PROPOSALS ON ARMY TOPICS

Phase I proposals (5 copies) should be addressed to:

Topics #1 through #17

Commander  
Armament Research and Development Center  
US Army Armament, Munitions and Chemical Command  
ATTN: DRSMC-PRC(D)  
SBIR Program  
Dover, NJ 07801

Topics #18 through #21

Commander  
US Army Armament, Munitions and Chemical Command  
ATTN: DRSMC-PR-B(A)/Mr. Henry  
Procurement Directorate, Edgewood Site/Bldg E4455  
Aberdeen Proving Ground, MD 21010

Topics #22 through #25

Commander  
US Army Aviation Systems Command  
ATTN: DRSAB-PSRS  
SBIR Program  
Building 102  
4300 Goodfellow Blvd.  
St. Louis, MO 63120

Topics #26 through #27

Commander  
US Army Communications-Electronics Command  
ATTN: DRSEL-PC-CM-E  
SBIR Program  
Ft. Monmouth, NJ 07703-5008

Topics #28 through #52

Commander  
Harry Diamond Laboratories  
ATTN: Contracting Officer, Bldg 205  
SBIR Program/Topic No. \_\_\_\_  
2800 Powder Mill Rd.  
Adelphi, MD 20783

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Topics #53 through #59

Commander  
US Army Belvoir R&D Center  
ATTN: STRBE-PM/P&P Division  
SBIR Program  
Ft. Belvoir, VA 22060

Topics #60 through #66

Commander  
US Army Missile Command  
ATTN: DRSMI-ICDA  
Building 4488  
SBIR Program  
Redstone Arsenal, AL 35898

Topics #67 through #75

Commander  
US Army Tank-Automotive Command  
ATTN: DRSTA-IRR  
SBIR Program  
Warren, MI 48090

Topics #76 through #80

Director  
US Army Materials and Mechanics Research Center  
ATTN: DRXMR-PP  
SBIR Program  
Watertown, MA 02172

Topic #81

Commander  
US Army Armament, Munition and Chemical Command  
Procurement Directorate-Edgewood Site  
ATTN: DRSMC-PR-B(A)  
Bldg E4455  
SBIR Program  
APG-EA, MD 21010

Topics #82 through #85

Commander  
US Army Natick Research and Development Center  
ATTN: STRNC-P  
SBIR Program  
Kansas Street  
Natick, MA 01760

Topic #86

Commander  
Engineering Topographic Laboratories  
ATTN: ETL-PRO  
Plans & Programs Office  
Building #2592, Room AG  
SBIR Program  
Ft. Belvoir, VA 22060

Topics #87 through #102

Commander  
US Army Medical Research and Development  
ATTN: SGRD-RMA  
Ft. Detrick, Frederick, MD 21701

Topics #103 through #108

Commander  
US Army Research Institute for the Behavioral and Social Sciences  
ATTN: PERI-PO  
Room 6E06  
5001 Eisenhower Avenue  
Alexandria, VA 22333-0001

Topic #109 through #111

Commander  
BMD Systems Command  
ATTN: Small and Disadvantaged Business Utilization Office  
P.O. Box 1500  
Huntsville, AL 35807

Army Research Topics for FY85 SBIR Solicitation

1. TITLE: MICRO-MINIATURE ELECTRONIC/OPTICAL ROLL RATE SENSOR FOR IMPROVED SMART MUNITIONS PERFORMANCE

CATEGORY: Exploratory Development

DESCRIPTION: Currently manufactured roll rate sensors are expensive to manufacture, have significant power consumption and require storage of compressed gasses on board. New and innovative roll rate sensor designs are sought which will have similar to better performance specifications but none of the currently experienced design shortcomings. Ideally, such a design concept will be of a smaller size and lighter weight than the present concept and further enable a reduction of the overall projectile weight through reduced power requirements and elimination of on-board storage of compressed gas. The sensor's output should be digital and thereby reduce the time required for interrogation by the system's guidance computer.

2. TITLE: MICRO-MINIATURE ELECTRONIC/OPTICAL ACCELERATION SENSOR FOR IMPROVED SMART MUNITIONS PERFORMANCE

CATEGORY: Exploratory Development

DESCRIPTION: Innovative approaches for acceleration sensors are needed with improved performance capabilities. Improvements in guidance technology are dependent on development of acceleration sensors with wider ranges of operation and capabilities for multi-dimensional resolution of motion. New concepts for acceleration sensors are sought which may have applications for angle of linear rate sensing and which will encourage digital signal processing. The acceleration sensor should be of minimal size and weight while retaining the performance requirements for guided projectile applications.

3. TITLE: MICRO-MINIATURE ELECTRONIC/OPTICAL SAFE SEPARATION SENSOR FOR IMPROVED SMART MUNITIONS PERFORMANCE

CATEGORY: Exploratory Development

DESCRIPTION: Existing technologies applied to acceleration sensors for detection of safe separation distance and timing are unsuitable due to limited range, size, reliability, ruggedness and cost. Novel concepts for an intrinsically stable and simple accelerometer for safe separation sensors for guided and smart munitions are therefore sought. The desired accelerometer should be a micro-miniature device of absolute minimum dimensions. Its range of operation should be within fractions of a G to tens of G's. By design, the proposed concept should be able to withstand rough handling, wide ranges of ambient temperatures, and random launch and flight vibrations.

4. TITLE: MICRO-MINIATURE ELECTRONIC/OPTICAL MAGNETIC MOMENT SENSOR FOR IMPROVED SMART MUNITIONS PERFORMANCE

CATEGORY: Exploratory Development

DESCRIPTION: The development of compact, high sensitivity, moderate magnetometer technology. Large magnetic moments generally represent real targets which are not as easily or cheaply produced as other decoys. Thus, incorporation of magnetic moments sensors into a "smart" projectile targeting system could improve overall performance by rendering it less vulnerable to decoys. Innovative concepts are sought which will encourage this sensing technology. Other potential applications include magnetic antennas for detection of EM signals and compass headings.

5. TITLE: DYNAMIC HIGH PRESSURE - HIGH TEMPERATURE DIAGNOSTICS

CATEGORY: Exploratory Development

DESCRIPTION: Innovative approaches are solicited for the measurement of pressure and temperature in the hostile environments of gun interiors. Diagnostics which are applicable at temperatures in the range of 3000°K and pressures of 700 MPa are required. The sensors must respond to dynamic fluctuations with risetimes of 0.1 msec or less. The proposals should address novel approaches to the requirement for rugged sensors and techniques which can be used to measure interior ballistic parameters such as pressure, temperature and heat transfer in large caliber (105mm and greater) guns.

6. TITLE: ADVANCED GUN PROPULSION TECHNOLOGY

CATEGORY: Exploratory Development

DESCRIPTION: Development of advanced solid and liquid propellant gun systems offers the potential for application of new technology in several areas. Characterization of liquid propellant systems is of considerable interest including ignition and combustion aspects and flow visualization. Proposals are solicited which address the design, improvement, and development of gun propulsion systems and propelling charge design. Areas of interest include development of novel energetic materials for igniters and propellants, novel methods of ignition, application of advanced diagnostics to ignition and combustion and muzzle flash characterization, measurement of in-bore projectile acceleration and other new technology which can be applied to develop more efficient and higher performance gun systems.

7. TITLE: ADVANCED FIBER OPTIC TECHNOLOGY

CATEGORY: Exploratory Development

DESCRIPTION: Significant advances are being made in fiber optic sensor technology and the complementary digital data processing equipment required for data acquisition and reduction. It is feasible to consider one-time

use sensor elements which are capable of measuring pressure, temperature and mechanical stresses. This advanced sensor technology should be exploited for use in measuring interior ballistic parameters such as chamber pressure, flame temperature, projectile acceleration and projectile-tube interactions. Proposals are solicited for innovative approaches to employing fiber optic technology to characterize interior and in-bore ballistic in large caliber guns.

8. TITLE: MATERIAL REPLACEMENT

CATEGORY: Basic Research

DESCRIPTION: Develop a suitable replacement for Nylon 6/6 for ammunition applications that will not be affected by explosives, propellants, or humidity.

9. TITLE: GUN BARREL DEVELOPMENT

CATEGORY: Exploratory Development

DESCRIPTION: Develop a composite/ceramic gun barrel that will be substantially lighter and have the same service life as the steel barrels now used on small caliber ammunition.

10. TITLE: COMPOSITE MATERIAL SHEAR STRENGTH

CATEGORY: Exploratory Development

DESCRIPTION: A method is needed to substantially increase the shear strength of molded threads and flanges fabricated by compression molding of discontinuous fiber reinforced molding compound.

11. TITLE: FRACTURE TOUGHNESS CHARACTERIZATION OF FILIMENTARY METAL  
MATRIX COMPOSITE MATERIALS SYSTEMS

CATEGORY: Basic Research

DESCRIPTION: The discipline of fracture mechanics is widely used in assessing the safety and reliability of military equipment; at the present stage of development this science assumes the materials are homogenous and isotropic. Most of our commonly utilized material systems reasonably meet these assumptions. However, in the future, filament reinforced metal matrix composite material will be applied. It will be necessary to determine the fracture toughness of this class of materials which do not meet the homogenous and isotropic assumptions. Innovative research and approaches are required to develop a methodology for determining this characteristic of metal matrix composites.

12. TITLE: LIGHTWEIGHT ARMAMENT SYSTEMS

CATEGORY: Exploratory Development



DESCRIPTION: The highly mobile and lightweight nature of future combat forces requires lightweight armament systems for light vehicle, air defense and aircraft applications. The need exists to significantly lighten present weapons systems and munitions, with no loss in effectiveness, through the use of advanced lightweight materials including composites, ceramics and plastics in weapon structural elements and operating components. The effects of such materials substitutions on system weight, operation characteristics, effectiveness, and reliability and maintainability should be investigated.

13. TITLE: ARTIFICIAL INTELLIGENCE ROBOTICS

CATEGORY: Basic Research

DESCRIPTION: A basic research program which has been initiated encompasses the fields of Artificial Intelligence and Robotics for applications to weapon platform control and fire control systems. The thrust of the program is to develop a fundamental understanding of symbolic processing with specific applications to machine learning, adaptive control, machine vision and expert systems.

14. TITLE: MACHINE VISION

CATEGORY: Exploratory Development

DESCRIPTION: Techniques or mathematical algorithms applicable for machine recognition of patterns are desired in support of fire control subsystems capable of recognizing targets on the battlefield. Emphasis is placed on efficient coding of target controls and on fast (real time) processing algorithms.

15. TITLE: OPTICAL PROCESSING

CATEGORY: Exploratory Development

DESCRIPTION: Integrated optical processors have a high potential for applications to Army fire control because of the intrinsic time-bandwidth constants available using guided electromagnetic waves rather than conducting electronics for transmitting and processing data. Methods of fabricating integrated optical processors are solicited as well as theoretical research leading to fundamental understanding of integrated optics phenomena.

16. TITLE: ARMAMENT SYSTEM SOFTWARE QUALITY - SOFTWARE TEST DRIVER DESIGN

CATEGORY: Exploratory Development

DESCRIPTION: There is a need for developing a generic prototype test driver which utilizes the concepts of structured testing and test path analyses. A proposed solution to this would be to obtain selected

commercially available tools, verify their performance, modify and consolidate tools to create the prototype, and then write a tailored user's manual for the Battlefield Automated Systems' tool. The objective of this would be to demonstrate that the developed software conforms to the system requirements and that a uniform level of confidence is achieved.

17. TITLE: ARMAMENT SYSTEM SOFTWARE QUALITY - REQUIREMENT ANALYSIS MEASURES

CATEGORY: Exploratory Development

DESCRIPTION: The critical task in developing software is the incorporation of design requirements into computer code. The correct implementation of requirements into the code is assessed by analyzing the requirements in terms of completeness, traceability, and consistency. These attributes must be evaluated before coding takes place. There is a need for measuring these attributes in a consistent means on all software development programs to assure that the project is ready for coding. SQAM Knowledge Engineering Data Base - Software Quality Assessment and Measurement is the control loop to the software development process. There is a need for an artificial intelligence, knowledge engineering, and data base to offset what will continue to remain a critical shortage of qualified SQAM personnel in the Army.

18. TITLE: STABILIZATION OF BIOMATERIALS

CATEGORY: Exploratory Development

DESCRIPTION: Thermophilic and halophilic microbes have evolved novel means of protecting DNA, RNA, enzymes, and other proteins from denaturation under environmentally hostile conditions. The use of antibodies in dipsticks for threat agents and toxins, and the use of antibodies, enzymes, and neural receptor sites in artificial membranes as coatings for biomicro-sensors (optical waveguides, surface acoustic-wave probes, piezoelectric crystals, chemical field-effect transistors) will require advanced methods of stabilization of proteins. The goal is to enhance shelf-life of such items under field and ship-board conditions.

19. TITLE: BIOMICROSENSOR TECHNOLOGY

CATEGORY: Exploratory Development

DESCRIPTION: Research and development should focus on: new methods of transduction of recognition events (antibody, enzyme, neural receptor sites) into electrical or optical signals; means to modify surfaces with biomaterials; methods of recognition amplification (including cascade systems) such that input is magnified  $10^5$  in less than 5 minutes; mechanisms to perform multiple assays in sequence using either regenerative or slow depletion phenomena; microencapsulation; and biomaterial-based detectors configured without liquid flow.

20. TITLE: MINIATURE PUMP FOR MASS SPECTROMETER CHEMICAL AGENT DETECTORS

CATEGORY: Exploratory Development

DESCRIPTION: A need exists to develop a small and rugged pump which could be used as the primary pumping system for future miniature mass spectrometer systems. This pump would be designed around the pumping requirements necessary to support the operation of an Atmospheric Pressure Ionization Tandem Mass Spectrometer (API MS/MS) including the loading due to certain gas and collision gas concerns (repumping requirements for the TAGA 6000 API MS/MS, Sciex). The development effort should address pump designs which can operate in a military environment and while in motion when the system is mounted in/on a vehicle. In addition, the design should address the basic needs of being compact, requiring a minimal of power, and being easily maintained.

21. TITLE: COLORIMETRIC CONCEPTS FOR RESIDUAL FILTER LIFE INDICATOR

CATEGORY: Exploratory Development

DESCRIPTION: A simple, reliable method is required to indicate to the user of a gas filter the amount of protection remaining. Previous efforts to develop a residual life indicator for gas filters were based on rather sophisticated electronic chemical detectors. These devices proved to be very unreliable and an urgent need for some form of indicator continues to exist. An approach which is considered to offer great promise for simple, reliable performance as a filter life indicator is an application involving the use of colorimetric chemical reactions. Such an indicator approach would provide a color change as the sorptive capacity of the ASC Whetlerite is depleted.

22. TITLE: ACTIVE CONTROL LANDING GEAR

CATEGORY: Exploratory Development

DESCRIPTION: Present approaches to crashworthy landing gears use hydraulic approaches to crash load energy absorption or a hydraulic/mechanical combination system. The hydraulic portion of the system is always loading rate sensitive, meaning that in severe crashes the high shock strut closure rates produce very high spike loads on the entire landing gear structure, causing it to fail before absorbing significant energy. Modern fluidics technology is showing the ability to give interactive control of the hydraulic gear metering function so that a more optimum "square wave" load-deflection landing gear characteristic can be obtained at any vertical impact velocity. This program will design and test such a system.

23. TITLE: ADVANCED CRASHWORTHY CREWSEAT

CATEGORY: Advanced Development/Non-systems

DESCRIPTION: The Army's present armored, crashworthy crewseats are a first attempt at protecting the pilots/copilots from the dual hazards of incoming

ballistic rounds and injurious loading characteristic of the Army's design crash pulse. During recent years, newer lightweight materials have evolved both in structural components and protective armor and more has been learned about human tolerance to severe impacts. This technology now needs to be applied to design a lighter armored crashworthy crewseat having improved crash protection.

24. TITLE: IMPROVED CREW RESTRAINT SYSTEM

CATEGORY: Advanced Development/Non-systems

DESCRIPTION: Analysis of recent severe Army helicopter accidents involving aircraft designed to stringent crashworthiness standards has shown the need for a new innovative crew restraint design. The present MIL-R-58095 five-point restraint fails to control lateral motion of the crewman in severe crashes sufficiently to prevent lateral secondary impacts. The new harness should incorporate revised geometry/strap sizes to better restrain the occupant in the lateral direction.

25. TITLE: IMPROVED THERMOPLASTIC MATRIX FOR COMPOSITE PRIMARY STRUCTURES

CATEGORY: Advanced Development/Non-systems

DESCRIPTION: In order to achieve the full potential of cost and weight reductions of composite material in aircraft primary structures, improved matrix materials for use with advanced fiber materials need to be developed. Thermoplastic has the ability of being thermoformed more rapidly than conventional epoxy systems and possess much longer shelf life properties even at room temperature storage. However, the current thermoplastic material systems do possess two disadvantages for primary structures as compared to their epoxy counterpart. In general, the material properties, especially interlaminar shear, are lower than epoxy systems. Secondly, the high temperature material properties degrade more rapidly as the material approaches its original cure temperature than epoxy systems.

The proposed work recommended would investigate new thermoplastic compounds to enhance basic material properties and investigate processes and compound additives to effectively change the thermoplastic to a thermoset plastic after final cure cycle.

26. TITLE: DISTRIBUTED COMMAND AND CONTROL APPLICATIONS - CECOM/CENCOMS

CATEGORY: Basic Research

DESCRIPTION: Emerging Technologies in Distributed Communications and distributed processing offer the potential of improving survivability and effectiveness of Command and Control (C<sup>2</sup>) processes.

The five functional system areas which comprise the Army's Command and Control System include maneuver, fire support, air defense, intelligence/EW and combat service support.

The objective of the thrust is to explore approaches to exploit these technologies to enhance the survivability and effectiveness of C<sup>2</sup> functions and processes. The emphasis of this effort shall be on the approach to survivable C<sup>2</sup> applications rather than on the distributed communications and distributed processing resources that underly these applications. In particular, this emphasis is on novel approaches which utilize advanced technology, e.g. decision aids, and involve synchronization of decision activity areas across several functions or echelons to achieve major gains in survivability and/or effectiveness through use of the underlying distributed communication and processing resources. Consideration will also be given to novel and effective applications of man-machine interface techniques which are well-matched to specific types of applications and echelon levels. Proposed applications may address any of the five functional areas.

27. TITLE: ARTIFICIAL INTELLIGENCE FOR C<sup>3</sup>I - CECOM/CENTACS

CATEGORY: Exploratory Development

DESCRIPTION: The tactics and doctrine of the modern battlefield dictate the need for intelligent machines to assist human operators. The technology associated with encapsulating knowledge and techniques used in AI to capture the reasoning process that human experts perform promises to provide a significant impact on future computer systems for the military.

Future military systems will be required to be self-learning and interactive. Self learning systems are systems that are able to make significant changes in their internal processing logic in response to user commands or based on demands which have been placed on the system in the past. These systems are extremely important in a military environment because they create significant operational capabilities across a diverse set of applications. They are fundamentally superior and inherently more reliable than the conventional rigid systems because they can be made more fault tolerant and possibly can be given limited properties of self-diagnosis and self repair.

In addition to self-adapting systems, the following AI technology advances are required to insure the adequacy of future military systems:

- (1) improved man/machine interfaces, such as natural language, speech and vision processing
- (2) the ability to represent and reason with data that is imprecise, incomplete, and not totally reliable and
- (3) new architectures that will provide the processing speeds and memory requirements as well as new languages and tools that will permit the communications with, and development on, these new machines.

28. TITLE: IMPROVED WIND PROFILER

CATEGORY: Basic Research

DESCRIPTION: Passive or covert methods for remote sensing of atmospheric winds need to be developed. Vertical profiles of atmospheric winds are needed for Army artillery, aviation operations, and prediction of smoke and chemical weapons effects. Existing methods for measuring atmospheric winds use the radiosonde, long-wavelength radar, or lidar techniques. Each of these suffers from significant defects which limit its usefulness as a field army sensor.

In particular, the radiosonde is bulky, manpower intensive, limited in space and time resolution, and hard to hide on the battlefield. Despite these limitations it continues to be the primary system for determination of battlefield winds.

Long wavelength (50 Mhz to 915 Mhz) radar has been shown capable of measuring atmospheric wind profiles up to tropopause with excellent time resolution on a continuous basis. Such radars require very large antennas and substantial power, however, which would give them enormous signatures on the battlefield, and their sheer size would seem to make deployment a problem. In addition, they are generally unable to measure winds in the lowest several hundred meters of the atmosphere which are usually the most important for army applications.

Lidar wind sensors can overcome many of the objections to the above systems. Like the long-wavelength radars, lidar wind sensors have good time resolution, and even better space resolution. Unlike the radars, they can measure winds near the ground. Lidars using either the cross-correlation technique or the coherent dopple technique would seem to offer the most promise, but they are limited to clear weather and still have substantial bulk.

New ideas and techniques are needed in this area. An ideal wind sensor would be small and passive, or at least relatively covert. It is necessary to measure vertical wind profiles at least to a height of three kilometers and preferably to the tropopause. The vertical resolution should be 100 meters or less in the boundary layer and 500 meters or better above. Velocity resolution of 1 m/sec or better is highly desirable. Even if these ideal standards cannot be met, new ideas are needed for more covert wind sensors, as are ideas that help overcome any of the defects of existing sensors listed above.

29. TITLE: LIDAR INVERSION AND THE RELATIONSHIP BETWEEN BACKSCATTER  
AND EXTINCTION

CATEGORY: Basic Research

DESCRIPTION: Remote sensing devices for measuring visibility, cloud height, pollutants, etc., in the atmosphere generally depend on inversion algorithms that convert returned power to the extinction coefficients. In order to construct a solution to the lidar equation one generally assumes a

simple power-law relationship between backscatter and extinction, with a fixed exponent and constant of proportionality. It then becomes possible to obtain extinction as a function of range, based on the physical picture that particulate backscatter acts as a distributed mirror by which range-dependent signal information is received.

It is known, however, that the power law representation is a rather idealized approximation, and can be expected to be of dubious value in some circumstances. For example, for a situation in which it is known that the distributed backscatter changes abruptly at the range where one aerosol is imbedded in another, such as for a pollutant cloud in otherwise clear air, the simple fixed power law description is apparently inappropriate. In general, it would be better to obtain a description that recognizes the fact that the proportionality between backscatter and extinction is itself a function of range, and to incorporate this more accurate physical picture into the inversion process.

30. TITLE: HIGH RELATIVE HUMIDITY MEASUREMENT

CATEGORY: Basic Research

DESCRIPTION: A need exists for the accurate measurement of the wet bulb or dew point temperature to determine relative humidity when it is above 95 percent. It is known that the relative humidity or the amount of moisture in the atmosphere has an important effect upon the growth of natural aerosols and upon the consistency or life span of smoke aerosols. Various chemical, biological, and radiological agents have greater reaction rates when the atmosphere is very moist.

The relative humidity parameter is an important input to several of the atmospheric effects models that the US Army Atmospheric Sciences Laboratory is developing. Obscuration parameters such as fog and smoke depend upon the amount of moisture in the air for their formation and life span. These factors are particularly critical during the period of high relative humidity. A satisfactory technique to measure relative humidity in the 97-100 percent range does not exist. Most instruments become saturated with the ambient moisture and become unreliable and yield inconsistent measurements near 100 percent. This is the period of time when the visibility is critical in the detection, recognition, and guidance of missiles to a target, for example.

31. TITLE: NEW CONCEPTS FOR MILLIMETER WAVE ELECTRONIC SCAN ANTENNAS

CATEGORY: Exploratory Development

DESCRIPTION: To realize low cost compact transducers, a simple electronic scan approach is required for the 30-100 GHz region. Any promising, novel approaches that are simpler than conventional phased array are of interest.

32. TITLE: MILLIMETER WAVE MICROSTRIP CONTROL COMPONENTS

CATEGORY: Exploratory Development

DESCRIPTION: Control components such as circulators, isolators, phase shifters, and switches that are compatible with low cost planar construction in microstrip or similar format are sought for the 30-100 GHz region.

33. TITLE: SOLID STATE COMBINER CIRCUIT

CATEGORY: Exploratory Development

DESCRIPTION: Efficient combiners with a 5% bandwidth and high power performance (1-50W) at millimeter wave frequencies. Concepts that simplify conventional combiners to increase reliability and reduce cost will be supported.

34. TITLE: RESEARCH IN ARTIFICIAL INTELLIGENCE (AI) APPLIED TO ELECTRONIC WARFARE (EW) SYSTEMS

CATEGORY: Exploratory Development

DESCRIPTION: In the EW Mission, there are several application areas that appear as likely candidates for the use of AI techniques. Some of these include: ELINT System Management, Jammer Power Management, Threat Warning, Management of Unmanned Systems, Simulation, Maintenance, and Training. In each of these areas, there is a significant need for human expertise in terms of background, experience, and judgement. The primary goal in the application of AI techniques to EW systems is to capture the knowledge of experts and replicate it for use by non-experts. An extension of this goal is to replace the human operator, especially when logistic or hazardous considerations make replacement appropriate.

35. TITLE: CO-CHANNEL INTERFERENCE REJECTION DIRECTION FINDING (DF) PROCESSING TECHNIQUES

CATEGORY: Exploratory Development

DESCRIPTION: The need exists for the development and demonstration of algorithms, techniques and processors capable of providing high resolution Electronic Support Measures (ESM) DF measurements against hostile radar threats operating in the presence of co-channel interference. These techniques must be capable of working against a mix of both broad spectrum, long pulse, and short pulse emitters.

36. TITLE: AIRCRAFT MULTI-SPECTRAL RADIO FREQUENCY (RF)/ELECTRO-OPTICAL (EO)/INFRARED (IR) COUNTERMEASURES

CATEGORY: Exploratory Development

DESCRIPTION: Analysis needs to be performed to determine how to counter weapon systems that have integrated RF/EO/IR target acquisition and tracking systems. Successful jamming of these systems may require integrated Multi-Spectral Countermeasures.



37. TITLE: STEERABLE NULL CONTROL TECHNIQUES

CATEGORY: Basic Research

DESCRIPTION: Investigation of control algorithms for steerable null antenna processors used in HF, VHF, and UHF communications. Emphasis should be placed on Least Mean Square (LMS) processing with multiplexed control of several control loops using a single processing circuit.

38. TITLE: HIGH FREQUENCY ELECTROMAGNETIC SHIELDING EFFECTIVENESS OF SPECIALIZED CONDUCTIVE BOUNDARIES

CATEGORY: Basic Research

DESCRIPTION: The large part of currently available data on shielding effectiveness of conductive shields, braids, screens, and coatings is limited to frequencies below 100 MHz. The objective is to extend the electromagnetic shielding effectiveness data to an upper limit of 2 GHz. The nominal frequency range to be covered is 0.1 MHz to 2 GHz. Electrically conducting surfaces of interest are cable shields and braids, and optically transparent (to visible and infrared) screens and coatings.

39. TITLE: NEAR FIELDS OF SUBREFLECTOR IN CASSEGRAIN ANTENNAS

CATEGORY: Basic Research

DESCRIPTION: Develop reliable analytical/numerical techniques for accurately predicting the near field distribution in the vicinity of the subreflector of a microwave cassegrain antenna system. The objective is to establish detailed knowledge of the power distributed in the immediate neighborhood of the subreflector element. This is to provide guidance towards development of methods to hold off breakdown and to reduce the influence of factors that contribute to loss of efficiency of the overall system.

40. TITLE: BIASED TEM WAVEGUIDE ABSORPTION SECTION DESIGN AND FABRICATION

CATEGORY: Engineering Development

DESCRIPTION: Design and fabricate a biased coaxial ionized gas RF absorption measuring device to operate over a 100 MHz to 1 GHz frequency range. The device will be used in a system to measure RF absorption in an ionized gas as a function of the electric field between the inner and outer conductors of the coaxial waveguide section. Preliminary work will involve use of existing prototype design. Prototype design has been tested at ambient air pressure to date. Analysis and modification of prototype design is required to develop operations capability over 0.001 mmHg to 960 mmHg pressure range for a variety of gases, including air.

A number of devices corresponding to various coaxial impedances will be required, for example 25, 50, 100, and 200 ohms. Matched transition to 50 ohms must be incorporated in the design. Low atomic number material, such as aluminum must be used as much as possible to construction of the apparatus.

41. TITLE: SOFT X-RAY MODIFICATION FOR AURORA

CATEGORY: Exploratory Development

DESCRIPTION: The HDL Aurora Radiation Test Facility produces intense high energy bremsstrahlung (10 Mev) that is used to simulate gamma radiation from nuclear weapons in developing radiation hardened electronics. Recently a proof-of-principle experiment confirmed an innovative analytic prediction by Dr. Nino Pereira that the efficient high energy bremsstrahlung of Aurora could be converted to very intense soft x-rays of a type that could be used to test satellite systems in a way that could be as effective as those produced by dedicated soft x-ray simulators. This is significant, because these machines are expensive to build and additional test capability is required for satellite system testing.

The objective of this program would be to provide theoretical support, test planning, and hardware development support to assist in the development of a Soft X-ray Test Modification for the Aurora simulator. This development would lead to a useful soft x-ray test capability that would provide an environment of 20 Krads over 1000 a cm<sup>2</sup> test object.

42. TITLE: LOW TEMPERATURE MERCURY-CADMIUM-TELLURIDE (HqCdTe) EPITAXY

CATEGORY: Basic Research

DESCRIPTION: One of the current efforts in the epitaxy of HqCdTe is organometallic vapor phase epitaxy (OMPVE). The technique involves the pyrolytic (thermal) dissociation of cadmium and tellurium alkyls in the presence of mercury vapor. The on-set of dissociation and deposition is dependent upon a minimum temperature, whereas the quality and composition of the ternary material is highly sensitive to temperature changes. Although the method appears to have the greatest potential as a production oriented technique for high-quality material, it is still linked to a relatively high temperature requirement of approximately 400° C. At this temperature several things may occur that are undesirable: Unwanted diffusion between multilayers having different composition, thermal stress between layers, migration of dopants, formation of interfacial defects, etc. It would be highly desirable and a real improvement to be able to deposit HqCdTe at a much lower temperature.

Such low temperature epitaxy may be accomplished by the dissociation of the proper organometallics using high energy radiation such as broad-band UV lasers of proper output or even x-rays. Another possible method may involve the use of specific catalysts in conjunction with a particular method of low temperature depositions from organometallics.

43. TITLE: TUNABLE INFRARED LASER

CATEGORY: Basic Research

DESCRIPTION: An atmospheric transmission window exists in the 8 to 12 micrometer spectral range. Carbon dioxide lasers using various isotopes of CO<sub>2</sub> provide coherent radiation in the range of roughly 9 to 12 micrometers. Conversion efficiency of electrical excitation power to laser radiation output is typically in excess of 10 percent. It is desirable for a number of military applications to also have an efficient source of laser radiation in the 8 to 9 micrometers band and preferably one that is capable of providing tunable output over the complete 8 to 12 micrometers band. The purpose of this research effort is to explore techniques to provide such radiation. Indirect techniques such as Raman shifting and others are to be considered in addition to direct conversion. Desired output power is in the 1 to 10 watt range with efficiency of at least one percent is the initial goal.

44. TITLE: NEW SUBSTRATE MATERIALS RESEARCH FOR IR DETECTORS

CATEGORY: Basic Research

DESCRIPTION: The overall objective of this program is to improve the scientific understanding, establish growth and purification techniques and to demonstrate the superiority of CdZnTe or CdMnTe as a material for substrates. Until recently epitaxial growth of HgCdTe has been restricted to the use of CdTe substrates. CdTe suffers as a substrate material in several aspects. The lattice mismatch is reasonably small in a percentage sense best effects. The superiority of CdZnTe and CdMnTe is based on the ability to provide an exact lattice matched substrate to minimize defect production and generation in epitaxially grown mercury cadmium telluride IR detector materials. Lattice matching substrates is a significant step in improving the quality of IR focal plane array. Currently, photovoltaic and photoconductive infrared detectors employing high performance HgCdTe focal plane arrays have performance limited materials problems. Of high significance are line defects which prevail in the form of low angle boundaries and bulk defects caused by non-stoichiometry such as inclusions. Equally significant are point defects including vacancies, interstitial atoms, and impurity atoms. The pseudobinary CdTe-ZnTe and CdTe-MnTe system has little or no segregation in the region of interest resulting in homogeneous bulk grown material with a reduction in the bulk defects. The proposed research will make a significant improvement in the state-of-the-art of lattice matched substrate materials to be used for all future epitaxial HgCdTe growth programs.

45. TITLE: MID-INFRARED LASER SOURCE

CATEGORY: Basic Research

DESCRIPTION: There is an atmospheric transmission window in the 3.5 to 4.1

micrometer spectral range that may be exploited for a variety of military applications requiring laser radiation. There is a need for compact, efficient, electrically excited lasers that operate in that band. The purpose of this program is to investigate novel techniques to provide both pulsed and continuous laser radiation with high efficiency in this spectral band. Both direct conversion and indirect conversion techniques such as Raman shifting shall be considered for this purpose. Pulse power of at least 100 kilowatts and continuous power of at least 1 watt is desired.

46. TITLE: EW VULNERABILITY

CATEGORY: Basic Research - Advanced Development/Non-systems

DESCRIPTION: The US Army has an extensive program designed to stress its weapon systems to electronic warfare (EW) environments to establish their limits to hostile EW. This limit is called a system's EW vulnerability and this vulnerability is reduced by the incorporation of electronic countermeasures (ECCM) into the system being developed to harden it to hostile EW. The EW environments consist of electronic countermeasures (ECM) and electronic support measures (ESM) that are used to direct, locate, and identify systems on a modern battlefield. The Army EW vulnerability assessment program requires advances in all three of these areas (ECCM, ECM, ESM). Further, these advances must be matched with advances in the use of the electromagnetic spectrum which now encompasses radio frequency (RF), millimeter wave (mmw), infrared (ir), optical (O), and ultraviolet (UV) portions of the spectrum. The use of three or more of these regions is defined as multispectral and, because of the costs required to conduct EW vulnerability assessments, all advances are to be oriented to as broadbanded or multispectral frequency coverage as possible.

A very broad base of scientific knowledge exists regarding magnetic fields but, because of the short range and low field densities, magnetic fields have found small application in Army ESM techniques. Thus, we need to develop magnetic field applications that can be used to complement existing ESM techniques across the spectrum. Multispectral sensor concepts need to be developed to permit simultaneous measurements of military systems to establish system signatures over the measured spectrum. Multispectral radomes (20' x 34" x 40") capable of permitting measurements simultaneously across RF, mmw, ir, O, and UV frequencies in a KC-135 aircraft environment are required for air-to-air and air-to-ground measurements.

Two major areas of ECM advancement are required. These are advanced chaff and smart munitions ECM techniques. Advanced chaff techniques are required for multispectral ECM environments. The chaff techniques proposed should consider the type of material, form, and development technique. The smart munitions ECM techniques must be as broadbanded (multispectral preferred) as possible to minimize the costs in applying them to a wide variety of munitions currently undergoing development.

The ECM advances required are for electro-optical (EO) devices. These ECCM techniques should be used to reduce effects of lasers used as ECM against

the EO devices. Emphasis should be placed on ir, television, nightsight, and UV systems.

47. TITLE: INTELLIGENT SENSOR RESOURCE MANAGEMENT

CATEGORY: Basic Research

DESCRIPTION: Assume the existence of an Army tactical situation (e.g. Blue vs Red). Further assume the existence of an arbitrary set of Blue Army intelligence sensor resources which include, but are not limited to, the following types: SIGINT, IMINT, and HUMINT. Assume that this set of sensors is configured non-optimally and deployed to perform some information/data gathering function in support of the Blue Army intelligence production requirements.

In addition, assume that the intelligence process is automated and results in the generation of a set of probable Red Army OB (order of battle) hypotheses. This situation assessment paradigm is assumed to be comprehensive and makes use of a wide diversity of input information while generating its threat OB. Information processed includes available intelligence sensor data, which has been distilled and preprocessed by Army intelligence analysts; battlefield terrain information and weather conditions; equipment logistic requirements; potential equipment synergism; a knowledge of Red Army doctrine; special domain features such as roads and bridges, and numerous other factors. The melding of this information provides an assessment of the enemy OB in a process called intelligence fusion. The major source of information indicating enemy intent is provided by the set of intelligence sensors available to and managed by the intelligence staff officer (G2).

A set of intelligence sensors can be used by the G2 in two ways: 1) to gather intelligence information, and 2) to validate or disprove hypotheses currently developed by the intelligence fusion process. A resourceful G2 is able to manage his sensor resources in such a manner as to optimize the potential of gathering useful intelligence information while simultaneously validating or disproving currently developed OB hypotheses considered important and crucial to the outcome of the tactical engagement. This type of resource management is clearly dynamic since resources may be deployed and committed to an objective only to have additional criteria develop which may alter the sensor mission objectives prior to the completion of existing mission objectives. In addition, mission management clearly requires that the mission manager be aware of the effects of the tactical domain (e.g. weather, terrain, vulnerability, hearability) upon each sensor and its ability to perform optimally as a single unit and synergistically with other sensor elements. Finally, the mission manager must be aware of Red Army doctrinal considerations and possible logistic constraints when considering a choice of possible sensors for a mission; these considerations may profoundly alter the choice of type of sensor(s) deployed since doctrine and logistics may suggest possible Red Army deployment and usage of equipment.

#### Proposed SBIR Research:

The above discussion strongly suggests that the effective and timely management of sensor resources by the G2 is not a deterministic and well-understood process, but requires imagination and human-like intelligence. It is therefore proposed that basic research be directed towards the development of an Artificial Intelligence based paradigm which would be capable of providing Intelligent Sensor Resource Management given an arbitrary set of sensor resources, and arbitrary tactical domain in which the tactical scenario takes place, and a set of G2 (or an automated G2 process) developed OB hypotheses. Emphasis should be given to the development of a robust, artificial intelligence based, non-statistical paradigm which is truly domain independent. In addition, the paradigm must be capable of providing the human user with justification for its mission management recommendations together with the development of timely reports, which can be used by the G2, to rank order/alter/develop OB hypotheses. Finally, a limited-domain test implementation of this paradigm should be provided together with a proof of extensibility to actual tactical domains.

#### 48. TITLE: INTEGRATED POWER CIRCUITS

CATEGORY: Exploratory Development

DESCRIPTION: Jammer amplifier and transmitter circuits need to be lighter and cheaper. Integrated circuit technology has made low power analog and digital circuits extremely cheap. It is desired to perform similar integration on power circuits, handling 100-400 W output power per basic power module. These power modules would be in the HF and VHF bands, e.g. 1-100 MHz, 80-400 MHz. The basic power modules would be used alone or in assemblies to make up a large transmitter. The use of integrated circuit concepts should increase reliability and decrease costs. The circuit substrate could be used for a cooling surface and the circuit could be designed mechanically to have modular, self aligning cooling passages for liquid or air cooling when assembled in large transmitters.

#### 49. TITLE: HF JAMMING ANTENNA FOR HELIBORNE SYSTEMS

CATEGORY: Exploratory Development

DESCRIPTION: Pursue improvements in HF antenna systems for use on various helicopter platforms. Antenna applications will include communication and direction finding in the HF range. Due to space constraints, particular emphasis should be directed toward miniaturization and weight reduction, directionability and gain for jamming applications.

#### 50. TITLE: OWN JAMMING EXCISION

CATEGORY: Exploratory Development

DESCRIPTION: In some current jammers it is not possible to track a signal or search for another one while jamming is being conducted. The many

kilowatt ERP is dangerous to the microvolt sensitive receiver and large filters do not work because the receiver is desensitized to the point of not being functional. The current technique is to simply turn the receiver off via an isolation switch on the input. This, however, limits the jamming system in its speed of response to acquiring or reacquiring a signal. A means is needed of eliminating one's own jamming signal from the receiver and simultaneously allowing the receiver to stay on to capture the threat signal. The means of excision must not be exploitable by the enemy so that he would use the technique to eliminate our jammer. The technique must be able to handle several kilowatts ERP from the jammer yet allow a receiver with several microvolt sensitivity to operate satisfactorily. The receiver and jammer usually share the same antenna which may be a reasonable frequency-independent design, such as a log periodic.

51. TITLE: COMBINERS

CATEGORY: Exploratory Development

DESCRIPTION: Broadband high power handling but physically small combiners are required for HF/VHF jammers. The combiner needs to cover the contiguous HF/VHF band as much as possible and handle from hundreds of watts to several kilowatts of input power. Conventional transmitters are made up of many basic power modules in parallel adding their power through combines to achieve high power outputs. The losses of present combiners require excessive numbers of power modules for power offset; the bandwidth of present combiners restrict multi-octave system design perhaps unnecessarily.

52. TITLE: POWER/FREQUENCY ADAPTIVE AMPLIFIERS AND TRANSMITTERS

CATEGORY: Exploratory Development

DESCRIPTION: Present jamming systems are broadband, e.g. 10-80 MHz to handle a variety of threats. Extension of this bandwidth capability to handle the entire HF/VHF, 3-300 MHz, is a very desirable but an extremely difficult design problem to handle power efficiently and to minimize spurious outputs, harmonics, efficiently couple to antenna, etc. In many military problems the presented threat may only occupy a portion of the jammer's bandwidth, hence the system is in a sense overdesigned. It is desired that the jamming system be able to automatically reshape its output frequency response to match a given threat. The system should also be able to change its class of operation, e.g. from Class A to Class B, when it might be allowable to produce more harmonics in order to produce more power vs a given threat. This reconfiguration capability should be executable in seconds under software/firmware control, i.e. under an artificially intelligent system controller. When the system reconfigures itself relatively slowly, it should retain a reasonable instantaneous bandwidth. In the case of, for example, 3-300 MHz range, the instantaneous bandwidth could be 3-10 MHz one time, 30-80 MHz the next, so that in any dense RF subband, instantaneous jamming response would be available. A benefit of this approach to transmitter design is that one variable 3-300 MHz jammer

could replace several narrow band jammers. Hence, logistics costs can be significantly reduced.

53. TITLE: MULTI-HOLLOW COMPOSITE SHELL BRIDGE DECK

CATEGORY: Exploratory Development

DESCRIPTION: Deck is to be a low density, tough composite material which is reinforced with high strength to weight fiber (graphite, kevlar). The material will be formed into a cylindrical shell with pinned ends to form a segment of a circular arch. The surface of the material will be in direct contact with tire and tank treads and be required to sustain high loads under very aggressive conditions.

54. TITLE: REGENERATIVE SULFUR SCRUBBER

CATEGORY: Exploratory Development

DESCRIPTION: Processing of liquid hydrocarbon fuels containing sulfur to generate a dirty hydrogen gas stream has been demonstrated. Secondary processing of the stream is required to enrich hydrogen and reduce carbon monoxide content before it is suitable for use in a phosphoric acid fuel cell. A compact regenerative scrubber capable of continuous removal of sulfur compounds is desired to prevent poisoning of secondary processing catalysts.

55. TITLE: GASEOUS CARBON DIOXIDE, HYDROGEN, OR WATER VAPOR SEPARATOR

CATEGORY: Exploratory Development

DESCRIPTION: Generation of hydrogen streams from hydrocarbon fuels suitable for use with a phosphoric acid fuel cell could be enhanced if:

- a. Carbon dioxide could be removed from the hydrogen stream;
- b. Water vapor could be separated and utilized in the fuel processor;  
or
- c. Hydrogen could be separated for direct feed into the fuel cell.

To be attractive, a device to accomplish any of the above should be capable of continuous operation at temperatures approximating fuel processor temperatures.

56. TITLE: SMALL THERMAL STORAGE DEVICE

CATEGORY: Exploratory Development

DESCRIPTION: Study and develop a cold heat sink (thermal storage) for combat vehicle environmental control during silent watch operation. Device would require negligible power to operate.



57. TITLE: REVERSE OSMOSIS MEMBRANE ELEMENT CLEANING

CATEGORY: Exploratory Development

DESCRIPTION: Investigate the feasibility of using alternative improved procedures for the cleaning of fouled spiral-wound reverse osmosis membrane elements used in Army reverse osmosis water purification units. There is evidence that current cleaning procedures employing citric acid and Triton X have an adverse effect on the performance of these elements. The objectives of this investigation are to determine the cause of this degradative effect and to develop an improved simple, effective, field procedure for cleaning these membrane elements which are currently being procured from three manufacturers who supply three chemically different membranes.

58. TITLE: FIELD METHOD OF MONITORING WATER SUPPLIES FOR RADIOACTIVITY

CATEGORY: Exploratory Development

DESCRIPTION: Establish the feasibility of determining the concentration of radioactivity in water at the Army MPC (Maximum Permissible Concentration) level of 1000 picocuries per liter of mixed fission products in the field. The method must be practical for use under battlefield conditions, i.e., the equipment must be simple, rugged, lightweight, of low cubage, and operable in a radiation field in the order of 100 milliroentgens per hour.

59. TITLE: PIPELINE CORROSION AND FRICTION REDUCTION COATINGS

CATEGORY: Exploratory Development

DESCRIPTION: Investigate the feasibility of coating military pipelines for corrosion protection and internal friction reduction. The investigation would identify the available coating material(s), the most effective coating material and the most cost-effective material.

60. TITLE: FOLDING WING MECHANISM

CATEGORY: Exploratory Development

DESCRIPTION: A need exists to develop mechanisms which permit large wings to be deployed from a missile after being launched from a tube or cannister. The mechanism must permit long term storage of the missile in the tube or cannister, and the mechanism must provide for deployment of cruciform wings which have planform areas that are about one-fourth to one-half the body planform area for each panel. The aspect ratio (exposed span/average chord) for each wing panel will be from two to four, with taper ratios (tip chord/ root chord) from 0.25 to 1.0. In the deployed position, the wings must be rigid, accurately aligned, and aerodynamically smooth and efficient.

61. TITLE: ANALYSIS OF IMPACT OF MISSILE CROSSING VELOCITY ON SHAPED  
CHARGE PENETRATION PERFORMANCE

CATEGORY: Exploratory Development

DESCRIPTION: A need exists to analytically estimate the degradation of shaped charge penetration performance into conventional and advanced armor caused by the misalignment of the missile velocity vector and the shaped charge jet velocity vector. Such misalignment occurs when the warhead is fixed at some angle relative to the longitudinal axis of the missile or when the missile flies at some angle of attack relative to the missile velocity vector. Under certain conditions, an intentional misalignment promises increased warhead lethality, but before such a design can be optimized, it is essential to be able to estimate the penetration degradation when such variables as missile velocity, alignment angle and shaped charge jet characteristics are varied. Proposals addressing this need can be applied to efforts in antitank guided munitions and should be classified secret.

62. TITLE: INERTIAL INSTRUMENT/SYSTEM INITIALIZATION/CALIBRATION TECHNOLOGY

CATEGORY: Exploratory Development

DESCRIPTION: There is a critical need for a means to calibrate low cost inertial (LCI) systems installed in a missile. LCI instruments, having a potential for midcourse missile guidance mechanizations, do not need long term stability but they do need good day-to-day repeatability. An internal initialization/calibration scheme would reduce the overall cost of ownership while maintaining the performance of inertial instruments/systems since they would be calibrated immediately prior to use. This task will address more effective ways of implementing various initialization/calibration techniques through the use of algorithms, computers, and theoretical analyses.

63. TITLE: DYNAMIC BORESIGHT MENSURATION

CATEGORY: Exploratory Development

DESCRIPTION: A means is required to measure in realtime the boresight error and aimpoint between a missile or rocket and the sighting or reference system. Once the capability to measure these errors (three axis system) is achieved, the true aimpoint can be established. It is preferred that the measurement technique be neither mechanical nor the comparison of separate inertial references. Currently, techniques are available to measure these errors for two axis but not three, as required. These systems use low power, narrow beam lasers, optics and sensor arrays and are in use in Directed Energy programs. The approaches should consider a high vibration environment, no mechanical or electrical linkage between the measurement points, night and day operations, no visible signature, operator safety, data rates and achievable accuracy versus cost. Results would include a brassboard demonstration along with supporting analyses.

Applications include hypervelocity rockets on helicopters, the reference system between the mast mounted sight and the inertial reference system on the Army Helicopter Improvement Program, multiple round artillery rocket systems, and the sighting and laying of LANCE and PERSHING.

64. TITLE: CORRELATION OF ULTRASONIC MEASUREMENTS WITH PROPELLANT MECHANICAL PROPERTIES AND IN-SITU PREDICTION OF PROPELLANT SERVICE LIFE

CATEGORY: Exploratory Development

DESCRIPTION: There is a need for the development of a mathematical model to relate ultrasonic time and frequency domain data, obtained from solid propellant samples, to parameters such as the complex loss modulus and the complex storage modulus. Computer codes should be developed to calculate and display these results using a digital computer. Also, there is a need to develop technology to non-destructively determine, in-situ, the mechanical properties of solid rocket motor propellant. This information is necessary to predict the service life of fielded missile systems.

65. TITLE: SYNTHESIS OF UNIQUE ENERGETIC POLYMERS AND OXIDIZERS

CATEGORY: Basic Research

DESCRIPTION: Synthesis of energetic polymers is desired that have special unzipping linkages (e.g., azo linkage) or linkages with strained ring molecules in the backbone that can be catalyzed to break or rearrange with energy release. The polymers must not contain the elements chlorine or sulfur and must have minimal metallic atoms. High oxygen content is desired. These polymer characteristics are believed to possess properties which will lead to higher burning rate minimum smoke propellants. The effort is to synthesize and characterize the polymers and evaluate compatibility with existing propellant ingredients. Advanced oxidizers containing energetic groups such as azidodinitromethyl, cyanodinitromethyl or trinitromethyl groups are of interest. The compounds of interest will have higher density and higher oxygen content than those of current minimum smoke propellant oxidizers. This effort will include characterization and compatibility testing of candidate oxidizers.

66. TITLE: HIGH DIELECTRIC STRENGTH MATERIALS FOR SHORT-PULSE ELECTRICAL STRESS

CATEGORY: Basic Research

DESCRIPTION: Solid dielectric materials and processes are needed which will exhibit extremely high resistance to rupture under conditions of short, fast-rising voltage pulses. The electric field stresses withstood should be in excess of 16 megavolts per centimeter at a material thickness of several centimeters. The electrical stress would be a single polarity rising from zero volts to maximum in one nanosecond or less and remaining high for a few tens of nanoseconds. These materials and processes must be

capable of being used for practical engineering and construction of high voltage pulse systems.

67. TITLE: ROBOTIC VEHICLE ENHANCEMENTS

CATEGORY: Exploratory Development

DESCRIPTION: In two to three years the Robotic Vehicle Demonstrator (RVD) will demonstrate advanced remote control/teleoperation techniques in Army User field tests. Advanced techniques in digital terrain analysis, route and path planning, internal and external land navigation stereo vision and other sensor systems will be evaluated. This program is a first step towards the demonstration of a semi-autonomous vehicle desired by the Armor Center under its operational concept "Modular Autonomous Robotic System (MARS)".

In order to accomplish semi-autonomous operation advances in the above techniques plus improvements in machine vision, artificial intelligence, image interpretation and processor control systems are required.

68. TITLE: DEVELOPMENT OF A DUST DETECTOR TO PROTECT ENGINES OF COMBAT AND TACTICAL VEHICLES

CATEGORY: Exploratory Development

DESCRIPTION: Failure of air cleaner systems is a major cause of engine failure. TACOM is currently investigating various methods of detection and alarm when particles are entering the engine. Methods include acoustical, electrostatic, light scattering and laser defraction. It is not clear what approach is optimum or whether investigations to date have been comprehensive. Requirements exist for inexpensive sensors with simple warning to the operator and for more elaborate systems which provide data with prognostic potential. Examples of this data would be particle size distribution, velocity at critical wear points and total ingested mass.

69. TITLE: QUICK DISCONNECT COOLANT HOSE

CATEGORY: Exploratory Development

DESCRIPTION: A major cause of engine failure in combat vehicles is loss of coolant, resulting in engine overheating. Cooling systems consist of a myriad of hoses connecting radiator(s), expansion tanks, engine and auxiliary coolers. Silicon or rubber hoses are connected to aluminum or steel fittings with heavy duty automotive screw actuated clamps. Connections may be "blind", causing incorrect installation, hoses deteriorate and harden, clamps fail, resulting in loss of the engine.

A solution is envisioned which would have similarity to hydraulic oil quick disconnects. Quick and positive connection and disconnect, combined with positive sealing and protection against massive contamination will provide protection against maintenance induced failures as well as ease of maintenance under field conditions.

70. TITLE: CORROSION

CATEGORY: Exploratory Development

DESCRIPTION: Corrosion is a problem that adversely affects the operational readiness of the Army's Tactical Wheel Vehicle Fleet, particularly in areas such as Hawaii, Panama, Michigan, Florida, etc. The need exists for a computerized data base to monitor this damage and, additionally, to reflect what efforts have been made to repair rust damage, indicating rate of repair, as well as efforts that have been made to retard rust damage such as thru conventional rustproofing. The data base would be expected to identify the vehicle, its location, and the nature of the rust damage; for example, stage 1, 2, 3, 4, with stage 1 being superficial surface corrosion and stage 4 being the most advanced, including perforation and loss of strength. Cost estimates to repair the damage would also be included.

71. TITLE: DIFFERENTIAL PRESSURE TRANSDUCER WITH VARIABLE ANALOG OUTPUT  
FOR USE WITH DCAS

CATEGORY: Exploratory Development

DESCRIPTION: The three-set-point differential pressure switches currently used with vehicle Diagnostic Connector Assemblies (DCAs) are only a low cost approximation to analog output differential pressure transducers. They provide little information about the actual conditions they are measuring, i.e., across a filter element. The analog output differential pressure transducer would give an indication of actual conditions at the filter under all conditions. It is necessary, therefore, to design a semiconductor type analog differential pressure transducer that can be used with new vehicle DCA Designs and Simplified Test Equipment.

72. TITLE: VEHICLE WASTE DISPOSAL SYSTEM

CATEGORY: Exploratory Development

DESCRIPTION: Develop a system for disposal of waste materials from interior of the vehicle, e.g., human waste, chemical agent decontamination material and other contaminated material. A system is needed to allow disposal of waste materials generated inside the vehicle while operating in an NBC contaminated environment without disposing to the outside of the vehicle. At present, it is a general practice to toss these waste materials out of the vehicle through a vehicle hatch. This practice will not be practical under closed hatch (buttoned-up) condition.

73. TITLE: VEHICLE INTERIOR CONTAMINATION AVOIDANCE SYSTEM

CATEGORY: Exploratory Development

DESCRIPTION: Study different contamination avoidance system concepts for

combat vehicles to protect vehicle interior while the crew enters the vehicle in a contaminated battlefield environment. Combat vehicles, such as M1 Tank and M2/M3 Bradley Fighting Vehicles, will have hard times keeping the interior of the vehicle clean (free of chemical contamination) under different fighting scenarios. A protective entrance for contamination avoidance is needed to reduce degradation in combat effectiveness. Otherwise, while entering from contaminated battlefield, crewmen will bring contamination into the vehicle.

74. TITLE: LONG LIFE TRACKS

CATEGORY: Exploratory Development

DESCRIPTION: This program is to develop new track design and manufacturing technology reversing the usual/classical approach of contracting to tire/rubber companies.

The aim would be to resort to designers and manufacturers of heavy duty conveyors to research and resolve the short life dilemma associated with tracks. The emphasis of effort would be directed towards a long life metal track with a secondary consideration for track pads reversing the present approach.

75. TITLE: ROADWHEELS

CATEGORY: Exploratory Development

DESCRIPTION: This would involve new design and manufacturing approaches to provide a roadwheel with longer life and greater ease of repair and maintenance by the field troops. Consideration would be given to "press-on" rubberized rims that would press-fit upon metal wheels.

76. TITLE: LIGHTWEIGHT MATERIALS AND MATERIAL SYSTEMS WITH IMPROVED ARMOR CAPABILITY

CATEGORY: Exploratory Development

DESCRIPTION: Primary threats to structured armor systems include small-, medium-, and large-caliber high density bullets as well as chemical energy warheads. These threats have shown a steady growth in lethality such that protection with conventional armor requires prohibitively high weights. New materials concepts are needed incorporating a capability of defeating selective munitions, surviving multiple hits, yet retaining structural capability at the lowest possible weight.

77. TITLE: HARD COATINGS FOR OPTICAL SYSTEMS

CATEGORY: Exploratory Development

DESCRIPTION: Broadband sensors require hard, erosion-resistant coatings which are transparent from ultraviolet, through the visible, well into the

infrared radiation wavelengths. New concepts for such coatings compatible with state-of-the-art optical materials are desired. Such concepts should also address the practicality of operating reliably and reproducibly in a production mode.

78. TITLE: IMPROVED PERFORMANCE IN RESIN MATRIX COMPOSITES

CATEGORY: Exploratory Development

DESCRIPTION: Innovative approaches are necessary to improve the performance of resin matrix composites. Areas which are being considered for study are:

a. Development of resin matrices exhibiting minimal or zero shrinkage during cure. Minimal shrinkage being less than 1/2 percent when cured at 177 C (350°F). Approaches such as the incorporation of spiro compounds into epoxy matrices will be considered. The resins should also exhibit mechanical and physical properties suitable for use in structural composites.

b. The mechanical properties of resin matrix composites produced by wet laminating techniques such as filament winding and pultrusion are often degraded by void formation. A method to eliminate or reduce the formation of voids due to entrapped air is required. Innovative approaches compatible with the wet laminating processes are being sought and would be considered under this topic.

c. A rapid non-destructive method for determining the resin/fiber content of fiberglass and/or aramid fiber composites is required. Current methods such as those approved by ASTM are time-consuming and require destruction of the sample. The proposed technique(s) should be applicable for fiber reinforced composites up to 1" thick and 60 fiber volume percent.

d. Manufacturing techniques for producing ambient-temperature, rapid-cure (2-4 hours) repair kit resins including prepregs with chemical and physical properties approaching those of 350°F cure high-performance epoxies would also be applicable under this topic.

79. TITLE: COMPOSITE SPECIMEN DESIGN ANALYSIS

CATEGORY: Exploratory Development

DESCRIPTION: One of the current problems associated with the mechanical testing of organic matrix composite materials is the inconsistency of the test data. A thorough analysis of specimen design would allow optimization of the configuration and eliminate specimen design as a contributor to inconsistent test results.

80. TITLE: NONDESTRUCTIVE EVALUATION TECHNIQUE

CATEGORY: Exploratory Development

CATEGORY: Exploratory Development

DESCRIPTION: An effort is needed for the nondestructive evaluation of ceramic materials. Requirement is to detect critical flaws in the 20 to 50 micrometer range. Technique must be able to scan or to inspect at least 6" square billets of material and allow evaluation of defects in the body of the material.

81. TITLE: ROBOTICS

CATEGORY: Exploratory Development

DESCRIPTION: Robotics is the topic of significant activity within the Department of the Army and AMC. Results of 3 years of effort in this technical area have led to an emphasis on combat service support/material handling issues as areas of maximum near-term leverage for robotics. The specific areas of technical interest include soldier-machine interface in the robotics context, e.g. new approaches to programming general purpose robotic materials handling/logistics equipment, field oriented safety systems which would permit soldiers to safely function within an operating robots work envelope. Robotics is currently funded under exploratory development (6.2) and is included in the Soldier-Machine Interface "new thrust" program initiative.

82. TITLE: PORTABLE DEVICE FOR DETERMINING SORPTION OF CHEMICAL PROTECTIVE GARMENT MATERIALS IN THE FIELD

CATEGORY: Exploratory Development

DESCRIPTION: A device is needed for testing chemically protective overgarments in the field. The device should either correlate with the standard carbon tetrachloride and/or agent penetration devices presently used to determine the sorbtivity of a garment or be actually a miniaturization of such a device. The test device shall use one or more appropriate procedures similar to those cited in MIL-C-4358A, or EATM 311-3 Laboratory Methods for Evaluating the Protection of Permeable Protective Clothing Against Chemical Agents, by Dawson and Gilchrist, 1967.

83. TITLE: TEST METHODOLOGY AND APPARATUS FOR MEASUREMENT OF STATIC ELECTRICITY IN FABRICS

CATEGORY: Exploratory Development

DESCRIPTION: There is concern over the propensity for static charging in Combat Vehicle Crewmen and aircrew uniforms made from polyaramid fibers. A stainless steel/polyaramid fiber blend is being considered to alleviate this problem.

The overall effort would require development of an effective test plan leading to correlation of percent stainless steel fiber content to the buildup and dissipation of static charges under varying conditions of



temperature and humidity. An appropriate test apparatus for this purpose must also be developed or adapted from existing equipment.

84. TITLE: STEAM GENERATOR

CATEGORY: Exploratory Development

DESCRIPTION: Develop a field steam generator, adaptable to military Field Food preparation systems and capable of using any untreated water. The unit should be easily cleaned and have a self-cleaning feature. The generator would provide the central energy source for a Field Food Service.

85. TITLE: DESIGN OF A HEAT SEALING MACHINE TO HERMETICALLY SEAL FLANGE-LESS POLYMERIC CONTAINERS

CATEGORY: Exploratory Development

DESCRIPTION: The protecting rim or collar of a container is called a flange. The flange provides an easy means of sealing polymeric containers. The flange, however, requires space within a shipping container and is vulnerable to damage during shipment and handling.

Fabrication of a flangeless container is no problem. This effort is to develop a sealing device that will hermetically seal a flangeless container. A laboratory unit will be required for experimental studies and the design should be such that scale-up to production speed equipment could be built.

86. TITLE: REFINEMENT OF CARTOGRAPHIC FEATURES IN AUTOMATED MAPPING SYSTEMS

CATEGORY: Exploratory Development

DESCRIPTION: Perform investigations on the use of graph theory as a means to organize the preliminary cartographic information obtained from automated mapping systems in a manner that cooperative and concurrent control of several processors will improve individual processor output and provide synthesized information from the several processors.

Current automated cartographic systems employing thresholding methods lost track when following road or stream features in the cluttered environment of digital aerial photography; techniques are required to overcome this problem if automated cartographic systems are to be fully effective.

87. TITLE: SMALL RODENT CYANIDE PRETREATMENT/THERAPEUTIC TEST SYSTEM

CATEGORY: Exploratory Development

DESCRIPTION: A small rodent mortality test system to quantify the antidotal activity of candidate new drugs against cyanide challenge is required. Studies will involve such effects as prophylactic and/or

therapeutic administration of compounds, acute LD 50 data, duration of effects, optimal times of administration, and therapeutic rations.

88. TITLE: PHYSIOLOGIC STABILIZATION AFTER TRAUMA

CATEGORY: Basic Research

DESCRIPTION: A general requirement exists to provide improved field care after traumatic injury when evacuation is delayed. The overall aim of this research and development is to provide treatment under adverse conditions that maximized salvageability and recovery once definitive care becomes available. Contemplated efforts cover a wide technological spectrum from state-of-the-art applications designed to improve and simplify first aid and resuscitative methods in the field to basic scientific investigations designed to explore unusual and innovative technical means for temporarily suspending or stabilizing pathophysiologic processes after traumatic injury.

89. TITLE: BLOOD BAGS

CATEGORY: Advanced Development/Non-Systems

DESCRIPTION: A requirement exists to develop rugged, plastic bags that can be stored with a preservative for ten years. The bags must be tolerant to wide temperature fluctuations within a 24-hour period.

90. TITLE: BLOOD PRESERVATIVES

CATEGORY: Basic Research

DESCRIPTION: A requirement exists to develop a new blood preservative that allows red cells to be stored up to 56 days while maintaining at least 80 percent of their original 2,3 diphosphoglycerate.

91. TITLE: BLOOD SUBSTITUTE

CATEGORY: Basic Research

DESCRIPTION: A requirement exists for a safe, efficacious emergency blood substitute for human use when whole blood is unavailable. Any proposed substitute should provide acceptable volume expansion as well as tissue oxygenation delivery capacity without requiring oxygen enriched breathing mixtures. Prolonged room temperature storage of the dehydrated material is desirable for logistic purposes.

92. TITLE: LYOPHILIZED PROTEINS IN PLASTIC BAGS

CATEGORY: Basic Research

DESCRIPTION: A requirement exists to develop a technique to fill sterile plastic bags with a sterile protein solution followed by lyophilization of the protein for long-term storage.

93. TITLE: PROTECTION OF MEDICAL EQUIPMENT AGAINST ELECTROMAGNETIC PULSE

CATEGORY: Engineering Development

DESCRIPTION: There is a need to protect current and projected equipment against burnout or alteration of electrical activity of components due to high altitude nuclear detonations. Such EMP effects may produce failure of life sustaining medical equipment as respirators, EKG and EEG apparatus, anesthesia machines, and laboratory measuring equipment. Simple, inexpensive solutions to protect power supplies and electronic circuits against burnout are required.

94. TITLE: OPERATOR STATUS AND FUNCTIONAL CAPABILITY ASSESSMENT

CATEGORY: Exploratory Development

DESCRIPTION: Recently developed enhanced technology systems, such as the AH-64 advanced attack helicopter and the M-1 Abrams main battle tank, are multimillion dollar systems carrying sophisticated, state-of-the-art weaponry and instrumentation. Modern tactical scenarios, such as CBR contamination, enhanced radiation weapons, or directed energy weapons could disable the operating personnel of these systems without appreciable damage to the system itself. Functional systems, treatable personnel, and intelligence information could be unnecessarily lost to enemy forces.

What is desired is an automated system that can monitor and assess the operator's functional status. This includes both biomedical (physiological) and behavioral status monitoring and evaluation. The system must have the intelligent capability of integrating the biomedical, behavioral, and vehicular parameter inputs and determining when the operator has become functionally capable of continuing or completing the mission. The output of this assessment would be used as evidence for transferring control of the vehicle to an automatic guidance and control system.

95. TITLE: ENVIRONMENTAL HEAT STRESS WEATHER NETWORK

CATEGORY: Exploratory Development

DESCRIPTION: There is a need to study the feasibility of implementing a standardized wet-globe temperature (WGBT) index data acquisition and retrieval network to support comprehensive computerized environmental intelligence resource for military operations conducted at specific sites, worldwide. Because of technological advancements in many aspects of military operations, the soldier's ability to function effectively has emerged as a critical "weak link" in the planning of military operations conducted in hot environments. The system would provide reliable projections of physiological impact on the soldier and associated tactical limitations and logistical requirements.

96. TITLE: RESEARCH IN EYE PROTECTION

CATEGORY: Basic Research

DESCRIPTION: Basic research in innovative approaches to the protection of the eye against high intensity light sources, including laser irradiation, are required. Exposure durations of light flashes may be in the picosecond to multisecond timeframes, with the possibility of repeated exposures. Wavelengths of interest for protection include the visible spectrum (400-700nm) and near infrared (700-1200nm). An otherwise completely transparent material, unless irradiated, is desirable as an end goal. Special emphasis should be directed toward the ultrashort exposure durations. Only preprototype test systems will be required.

97. TITLE: SUBUNIT VACCINES FOR MILITARY-IMPORTANT DISEASES

CATEGORY: Exploratory Development - Advanced Development/Non-systems

DESCRIPTION: Subunit vaccines are those composed of key portions of killed microorganisms. The aim of this effort is to rid the killed microorganism of undesirable components by utilizing the techniques of microbial engineering and identifying just those parts of an organism that are able to produce immunity without side effects and to utilize genetic engineering to produce these purified antigens in large quantities.

98. TITLE: DIAGNOSIS OF NATURAL AND INDUCED DISEASES OF MILITARY IMPORTANCE

CATEGORY: Exploratory Development - Advanced Development/Non-systems

DESCRIPTION: This effort is designed to provide state-of-the-art technology to develop a system for rapid identification and diagnosis of agents or diseases acquired naturally or by exposure to biological weapons. The system will provide for rapid identification of agents/diseases through examination of clinical specimens such as blood, urine, spinal fluid, and throat washings. The system should be extremely sensitive using very specific reagents such as monoclonal antibodies prepared through hybridoma technology. Methods utilizing the latest in biotechnology techniques should be utilized, such as labeled molecular probes for the identification and analysis of microbes or their products.

99. TITLE: PRODUCTION OF MAMMALIAN METABOLITES OF TRICOTHECENE MYCOTOXINS

CATEGORY: Advanced Development/Non-systems

DESCRIPTION: Specific metabolites of the trichothecene toxins that are produced in whole animals are needed in sufficient quantity to use as standards for analytic procedures and for toxicity testing. Multimilligram quantities would be required. The metabolites of T-2, DAS, and nivalenol are of principal interest.

100. TITLE: IMMUNOASSAY FOR T-2 TETRAOL

CATEGORY: Exploratory Development

DESCRIPTION: T-2 tetraol is a principal urinary metabolite of T-2 in mammalian systems. An assay effective in sensitively measuring T-2 tetraol in urine is needed to screen for prior exposure to T-2. Production of a sensitive immunoassay is desired.

101. TITLE: VACCINE DELIVERY SYSTEMS

CATEGORY: Exploratory Development

DESCRIPTION: A requirement exists for controlled-release systems, carriers, and/or adjuvants compatible with vaccines or subunit vaccines for high-hazard agents of specific interest to the Army. Additionally, a need also exists for new methods of immunization and/or mucosal immunity to these high-hazard agents.

102. TITLE: FALCIPARUM MALARIA FIELD ASSAY KIT

CATEGORY: Advanced Development/Non-systems

DESCRIPTION: Require development of a field kit composed of materials and instructions for conduct of a standardized enzyme-linked immunosorbent assay to detect falciparum malaria sporozoites. The kit should employ reagents that are currently available and test procedures/materials must be compatible with test systems currently under development by the Army. This work will require extensive testing to standardize test methods, reagents and results in terms of sensitivity and specificity.

103. TITLE: RESEARCH IN LEADERSHIP DEVELOPMENT

CATEGORY: Exploratory Development

DESCRIPTION: Research support is required for a comprehensive progressive sequential leader development program from the perspective of the total Army system. Of particular interest are: decisionmaking and decision support systems; cognitive skills assessment and development; the relations between leadership, unit/organizational effectiveness, and productivity; and senior leadership requirements.

104. TITLE: RESEARCH IN DEVELOPING OPTIMUM METHODS FOR MEASURING JOB PERFORMANCE

CATEGORY: Exploratory Development

DESCRIPTION: The Army is designing a total selection and classification system that involves predictor measures (to help select the right people and place them in appropriate jobs) and performance measures (to tell us how well the soldiers perform after joining the Army). Four types of

performance measures are of great importance to the Army: (1) training measures, i.e., measures of progress in the training situation; (2) MOS-specific measures, i.e., measures of actual performance on the job; (3) Army-wide measure, i.e., measures of "good soldiering" or soldier effectiveness that cut across all jobs; and (4) measures of unit effectiveness. The primary research need is for new approaches to performance assessment in each of these categories.

105. TITLE: MEASUREMENT AND MODELS OF EMPLOYMENT DECISION MAKING

CATEGORY: Exploratory Development

DESCRIPTION: Each year the Army must enlist and reenlist thousands of soldiers. In order to better recruit and retain high performing soldiers, it is important to be able to understand, measure, and model the variables considered by individuals in making their decision to join the Army or reenlist. These variables are also important in terms of the decision to enroll and continue in ROTC and to make a career as an officer in the Army.

106. TITLE: RESEARCH IN PROJECTING MANPOWER AND SKILL LEVEL REQUIREMENTS  
EARLY IN WEAPON SYSTEM DEVELOPMENT

CATEGORY: Exploratory Development

DESCRIPTION: Historically, the system acquisition process has been driven by cost, adherence to schedule, and hardware/software performance. Recently, increased emphasis has been given to early identification of the human resources needed to operate and maintain the new systems. Accurate estimates of the number of individuals and the skills they must possess provide a basis for: (a) comparisons with estimated future supply; (b) identification of system changes to reduce operator and maintainer requirements; and (c) selection among competing systems. Innovative techniques which can be used to generate quantitative and qualitative estimates of operator and maintainer requirements on the basis of information available during concept development are needed. Procedures for estimating ability requirements are especially desired.

107. TITLE: RESEARCH IN THE APPLICATION OF ARTIFICIAL INTELLIGENCE  
TECHNIQUES TO THE GENERATION OF OPTIONS IN PLANNING

CATEGORY: Exploratory Development

DESCRIPTION: It is anticipated that in tactical situations a decade or more in the future, decisionmakers and those planning large actions will be flooded with data which will have to be compiled, evaluated, and analyzed for use. Efforts are needed to determine optimal use of the computer to assist in such operations. Current planning algorithms implemented on computers today do not provide options for the planner or decisionmaker and are not sensitive to changing constraints or environmental conditions, nor do they provide anticipated outcomes with associated probability values. Research towards the development of such systems is urgently needed.

108. TITLE: RESEARCH ON COGNITIVE PROCESSES IN DECISIONMAKING UNDER  
UNCERTAINTY TIME STRESS

CATEGORY: Exploratory Development

DESCRIPTION: Commanders, intelligence analysts, and others are often required to make decisions under conditions of uncertainty and severe time stress. Uncertainties may be associated with missing, incomplete, or ambiguous information, or with future outcomes that are unknown. Research is needed to (1) better understand the cognitive processes (e.g., memory, judgment, or problem-solving) of the decisionmaker under such conditions, and (2) suggest approaches for supporting the cognitive processes so that the overall quality and timeliness of decisions made under uncertainty and time stress are enhanced.

109. TITLE: MEASUREMENT OF COMPUTER RADIATIONS FOR SECURITY REASONS

CATEGORY: Advanced Development/Non-systems

DESCRIPTION: Research and design a small portable device that can be used in the field to provide an economical and effective way to measure emanations which can be correlated to classified information being processed. This will provide the Armed Services indicators as to whether the emanations are detectable beyond the established control space.

110. TITLE: SONOBUOY TRACKING SYSTEM

CATEGORY: Advanced Development/Non-systems

DESCRIPTION: Impact scoring of missiles, bombs, and torpedoes has long been a challenge to the range instrumentation community. Bottom mounted hydrophones MILS (missile impact location system) and SDRs (splash detection radars) have been used effectively. However, in recent years the most accurate and versatile technique has been SMILS, a sonobuoy MILS. The limitation of SMILS is that the surface array of sonobuoys requires deep ocean transponders (DOT) for a geodetic reference. This limits the flexibility of the location, since the surface array can only be seeded over the DOTs. If a few selected sonobuoys in the surface array could be accurately tied to a land reference, the expendable surface array would be free of the DOT "anchor" providing complete flexibility for targeting (within sight of land).

A sonobuoy tracking system (STS) could be deployed (either by air or surface) within RF sight of a land reference and yield accurate impact scoring. The acoustic signature of the object into the water would be "heard" by the sonobuoy and the impact time and their location relayed to the shore station. By multilateration, a precise score (within 5 meters) could be derived. The problem is development of a device that would be placed on an expendable sonobuoy to track its location.

111. TITLE: DEVICE FOR MEASURING RADAR BEACON DELAYS

CATEGORY: Advanced Development/Non-systems

DESCRIPTION: Tracking beacons enhance the tracking capability of radars, but the beacon delay affects the range measurement. The beacon delay is measured long before flight, but this delay changes with time and flight environment and adds error/bias to the range data. Since a considerable number of radars have the capability of tracking an object in both skin and beacon using the same transmitted RF pulse, the beacon delay can be measured. This information would improve the accuracy of the range data, as well as give data on the stability of the beacon signal. This effort should be designed and developed in such a fashion that it could be attached to certain radars as a mod with appropriate radar signal being fed in.



NAVY SMALL BUSINESS INNOVATION RESEARCH PROGRAM  
Submitting Proposals on Navy Topics

Phase I proposal (5 copies) should be addressed to:

Topics #N85-1 through #N85-7

Office of Naval Research  
800 North Quincy Street  
BCT #1, Room 528  
Attn: Code 400 SBIR Program, Topic No. \_\_\_\_  
Arlington, VA 22217

Topics #N85-8 through #N85-20

Mail Address:

Commandant of the Marine Corps  
Headquarters, U.S. Marine Corps  
Attn: Code LBC-2 SBIR Program, Topic No. \_\_\_\_  
Washington, D.C. 20380

Handcarry Address:

Headquarters, U.S. Marine Corps  
1300 Wilson Blvd., Room 604B  
Attn: Code LBC-2 SBIR Program, Topic No. \_\_\_\_  
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Topics #N85-21 through #N85-35

Mail Address:

Commander  
Naval Electronic Systems Command  
Department of the Navy  
Attn: ELEX 00K SBIR Program, Topic No. \_\_\_\_  
Washington, D.C. 20363

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Naval Electronic Systems Command  
Room 1E58, National Center #1  
2511 Jefferson Davis Highway  
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Topics #N85-36 through #N85-39

Mail Address:

Commander  
Naval Sea Systems Command  
Department of the Navy  
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Commander  
Naval Sea Systems Command  
Room 850, Crystal Plaza #6  
2221 Jefferson Davis Highway  
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Arlington, VA

Topics #N85-40 through #N85-48

Mail Address:

Naval Supply Systems Command  
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Washington, D.C. 20376

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Naval Supply Systems Command  
Research and Technology Division  
Room 602, Crystal Mall #3  
1931 Jefferson Davis Highway  
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Arlington, VA

Topics #N85-49 through #N85-58

Mail Address:

Commanding Officer  
Naval Medical Research & Development Command  
Attn: Code NMC-NCR SBIR Program, Topic No. \_\_\_\_  
Bethesda, MD 20814

Handcarry Address:

Commanding Officer, Naval Medical Research & Development Command  
Bldg. 142, Taylor Street  
Attn: Code NMC-NCR SBIR Program, Topic No. \_\_\_\_  
Bethesda, MD

Topics #N85-59 through #N85-65

Mail Address:

Headquarters, Naval Air Systems Command  
Department of the Navy  
Attn: Code AIR-303 SBIR Program, Topic No. \_\_\_\_  
Washington, D.C. 20361

Handcarry Address:

Headquarters, Naval Air Systems Command  
Department of the Navy  
Room 424, Jefferson Plaza #1  
1411 Jefferson Davis Highway  
Attn: Code AIR-303 SBIR Program, Topic No. \_\_\_\_  
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Topics #N85-66 through #N85-112

Mail Address:

Naval Surface Weapons Center  
White Oak  
Attn: Code S-02 SBIR Program, Topic No. \_\_\_\_  
Silver Spring, MD 20910

Handcarry Address:

Naval Surface Weapons Center  
Bldg. #1, Reception Room  
White Oak  
Attn: Code S-02 SBIR Program, Topic No. \_\_\_\_  
Silver Spring, MD 20910

Topics #N85-113 through #N85-115

Mail Address:

Commander  
Naval Weapons Center  
Attn: Code 005 SBIR Program, Topic No. \_\_\_\_  
China Lake, CA 93555

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Naval Weapons Center  
Room 22  
515 Blandy Avenue  
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Topics #N85-116 through #N85-126

Mail Address:

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Naval Weapons Support Center  
Attn: Code 605 SBIR Program, Topic No. \_\_\_\_  
Crane, IN 47522

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Bldg. 2917  
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Crane, IN 47522

Topic #N85-127

Mail Address:

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Attn: Code 7012 SBIR Program, Topic No. \_\_\_\_  
Warminster, PA 18974

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Warminster, PA 18974

Topics #N85-128 through #N85-129

Mail Address:

Naval Underwater Systems Center  
New London Laboratory  
Attn: Code 10 SBIR Program, Topic No. \_\_\_\_  
New London, CT 06320

Handcarry Address:

Naval Underwater Systems Center  
New London Laboratories  
Bldg. 80, Room 2081  
Smith Street Entrance  
Attn: Code 10 SBIR Program, Topic No. \_\_\_\_  
New London, CT

Topic #N85-130

Mail Address:

Commanding Officer  
Naval Coastal Systems Center  
Attn: Code 401 SBIR Program, Topic No. \_\_\_\_  
Panama City, FL 32407

Handcarry Address:

Commanding Officer  
Naval Coastal Systems Center  
Room 2M72, Bldg. 110 (Main Administrative Bldg.)  
Attn: Code 401 SBIR Program, Topic No. \_\_\_\_  
Panama City, FL

Topic #N85-131

Mail Address:

Commanding Officer  
Naval Air Engineering Center  
Attn: Code 903R SBIR Program, Topic No. \_\_\_\_  
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Hangar No. 2  
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Lakehurst, NJ 08733

Topic #N85-132

Mail Address:

Commander  
Pacific Missile Test Center  
Attn: Code 3151 SBIR Program, Topic No. \_\_\_\_  
Point Mugu, CA 93042

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Trailer No. 10099  
Attn: Code 3151 SBIR Program, Topic No. \_\_\_\_  
Point Mugu, CA 93042

Topics #N85-133 through #N85-134

Mail Address:

Naval Training Equipment Center  
Attn: Code N-6 (SBIR), Topic No. \_\_\_\_  
Orlando, FL 32813

Handcarry Address:

Naval Training Equipment Center  
Bldg. 2005, Reception Area  
Attn: Code N-6 (SBIR), Topic No. \_\_\_\_  
Orlando, FL

Topic #N85-135

Mail Address:

Commanding Officer  
Navy Personnel Research and Development Command  
Bldg. 329  
Attn: Code 21B (SBIR), Topic No. \_\_\_\_  
San Diego, CA 92152

Handcarry Address:

Commanding Officer  
Navy Personnel Research and Development Command  
Bldg. 329  
Catalina Blvd. & McClellan Street  
Attn: Code 21B (SBIR), Topic No. \_\_\_\_  
San Diego, CA

Topics #N85-136 through #N85-138

Mail Address:

Joint Cruise Missiles Project Office  
Director of Contracts  
Attn: Code JCM-283 SBIR Program, Topic No. \_\_\_\_  
Washington, D.C. 20363

Handcarry Address:

Joint Cruise Missiles Project Office  
Director of Contracts  
National Center #1  
2511 Jefferson Davis Highway  
Attn: Code JCM-283 SBIR Program, Topic No. \_\_\_\_  
Arlington, VA

N85-1. TITLE: Surface Attack on Metals in the Presence of Liquid Metals Research

CATEGORY: Research

DESCRIPTION: Sodium-Potassium eutectic (NaK) has been identified as the primary candidate for use in liquid metal current collectors for superconducting homopolar electric machines. Under certain circumstances (e.g., very large, low speed motors) the use of higher density liquid metals has been found to be acceptable and results in superior electrical machinery. Preliminary experiments have indicated that quaternary or quinary solder-like alloys of various combinations of Bi, In, Cd, Pb, and Sn may be suitable as NaK substitutes at temperatures below 175 degrees F. It is anticipated that the material compatibility with collected metallic surfaces will be of greater concern when using such material than for the case of NaK which is relatively compatible with most metallics below 200 degrees F. This research task involves the investigation through literature search and/or direct experiment of the compatibility of the various metallics used in liquid metal current collectors with the liquid metals NaK, alloys of Bi, In, Cd, Pb, Sn, and GaIn alloys. A particular task is to determine relative solubilities of relevant solid metals in the liquids and the degree and type of surface attack or corrosion. This data will serve as a basis for the development of a theoretical model suitable for the prediction of surface phenomena for liquid/solid metal interfaces. The theoretical model may then be used as a guide for future selection of metals and alloys for use with liquid metals in applications involving temperatures in the 0-to-500 degree F range. (Bi-Bismuth; In-indium; Cd-Cadmium; Pb-lead; Sn-Tin; Ga Gallium).

N85-2. TITLE: Synthesis of Refractory Phosphides

CATEGORY: Research

DESCRIPTION: Develop innovative approaches to the synthesis of phosphides for use as infrared transmitting refractory ceramics. The objective is to produce phase pure material by techniques that are scalable to multi-kilogram lot sizes. Materials must be oxyanion free and have a low enough concentration of other impurities to achieve intrinsic absorption between 3 and 5 m. Binary, ternary, and quaternary compounds should be considered. Consideration should be given to low temperature routes such as reaction in nonaqueous solvents.

N85-3. TITLE: Remote Sensing Systems

CATEGORY: Research

DESCRIPTION: Develop unique or innovative techniques for remote sensing of environmental parameters (e.g., ambient acoustic noise, currents over the ocean water column) that require high data rates, data concentration, and minimum energy consumption. Data retrieval methods, including unit-to-unit transmission or unit-to-satellite/ground station, will be a critical part of this research effort. The objectives are to develop the capability to deploy long-term multiple sensor buoys or moored systems in remote locations. A secondary objective is to minimize the unit costs of such systems to avoid costly recovery operations.

N85-4. TITLE: Implementation of Logistics Software on Microcomputers

CATEGORY: Exploratory Development

DESCRIPTION: The proliferation of microcomputers will lead to new methods of practice for operations research professionals both inside the Navy and in the civilian community. Research over the last twenty years has been toward increasing the size and complexity of algorithms to handle more complex models. Methods now need to be developed to efficiently decompose problems and solve the components on microcomputers.

There are several issues which are significant in the design of such systems. Logistics applications typically require large amounts of data. Efficient management and display of this data using the limited microcomputer memory will require new model structures and algorithms, perhaps hierarchically organized at various levels of aggregation. Applications on mainframe computers prohibit human involvement - those on microcomputers require it. This requirement stems from the limited computational capacity available. The interface must be carefully organized to take maximal advantage of each of the participants. Many logistics applications require the expertise of a number of people. The software must be designed to allow each member to work independently with coordination and data communication when needed.

The initial phase of this research should be for the development of demonstration technology designed to study these or other issues of microcomputer implementation in a Navy application area. Possibilities for such areas include ship loading, inventory management, maintenance scheduling, and shipment planning.

N85-5. TITLE: Automated Welding

CATEGORY: Research

DESCRIPTION: The Navy has an interest in pursuing new and innovative research in automated welding of high strength, low alloy (HSLA) steels. The HSLA steels are being considered for use in ship construction. This program for welding research may employ advanced high deposition rate techniques or high density beam processes, but is not limited to them. The research focus should be on processes that lend themselves to automation and may include advanced sensors and robotics and mathematical models that predict needed information on seam tracking, weld pool geometry and/or weld integrity.

N85-6. TITLE: Immunopharmacology

CATEGORY: Exploratory Development

DESCRIPTION: A need exists for pharmacologic agents that can activate immune defenses against microorganisms, especially viruses. Agents that activate either nonspecific or specific immunity are of interest, but immune stimulants that protect against a wide variety of infections nonspecifically are of special importance to military medicine. Both prophylactic and therapeutic



pharmaceuticals are of interest. Suitable pharmaceuticals must be potentially safe for human use, economical to produce, convenient to use, and enhance resistance to or recovery from infectious agents.

N85-7. TITLE: Strip Mirror Echelons for Photolithography or Laser Annealing

CATEGORY: Exploratory Development

DESCRIPTION: The use of ultraviolet excimer lasers for micro-photolithography or annealing has been impeded by the difficulty in achieving sufficiently uniform illumination of the targets. This solicitation calls for the optics design and mechanical hardware to utilize the recently-invented "induced spatial incoherence" technique to achieve ultra-uniform illumination of targets (see R. Lehmberg and S. Obenschain, Optics Comm. Vol. 46, pg. 27, 1983). The ISI technique uses two echelons, each made up of two carefully aligned strip mirrors. (One can also use transmission or refraction echelons.) When alternate mirrors are tilted, the technique should produce nonuniformities of less than  $\pm 2\%$  in the far field, over a substantial portion of the beam, without speckle. A mirror echelon has already been successfully deployed in laser fusion research with an Nd:glass laser at the Naval Research Laboratory, producing beam nonuniformities less than  $\pm 10\%$  on a millimeter spot. Phase I of this solicitation calls for an optics and mechanical design that would be appropriate for an excimer laser, with a uniform spot over about one centimeter, and with a convenient alignment system. In later phases, a successful contractor would manufacture an iterative series of echelon assemblies that would demonstrate sufficient stability and reliability for commercial applications to photolithography or annealing.

N85-8. TITLE: Chemical Resistant Paints

CATEGORY: Advanced Development

DESCRIPTION: Paints in current use by the Marine Corps act as a blotter to toxic chemicals, especially those expected to be used against the Marine Corps in battle. The available decontamination processes strip the contaminated paints from the surface which they were protecting.

The objective of this work would be to develop a paint which would be easily applied and be either unaffected by chemical agents or be decontaminated without loss of the protective features of the paint for the metal surfaces.

N85-9. TITLE: Mine Detection Equipment

CATEGORY: Exploratory Development

DESCRIPTION: The Marine Corps requires equipment capable of detecting land mines/minelfields at a standoff distance of one to five kilometers forward of combat elements. The equipment must be usable in a field environment, transportable on tactical vehicles, and provide real-time, accurate information on minefield location. A negative response should assure that no mines are present.

N85-10. TITLE: Enhanced Conventional Explosives

CATEGORY: Exploratory Development

DESCRIPTION: The Marine Corps has a requirement for conventional (non-nuclear) explosives which can provide overpressures from 3,000 to 5,000 pounds per square inch over a 20-meter diameter area. The charge, when fielded, must meet current military standards concerning safety, transportability, storage, etc., and be usable in a field environment. Delivery methodology and equipment would be a separate development, once the explosive is satisfactorily attained.

N85-11. TITLE: Decoy Development

CATEGORY: Advanced Development

DESCRIPTION: The Marine Corps requires decoys to simulate various weapons systems, including motor vehicles, tanks, amphibian tractors, artillery weapons, and missile systems. These decoys must have identical thermal, visual, and radar signatures as the items they simulate.

N85-12. TITLE: Algorithm to Predict Levels of Cosite Interference

CATEGORY: Software Engineering Development

DESCRIPTION: The ability to predict the success of communication links in a network requires a level of engineering expertise not generally found in tactical communications officers. This situation is rapidly changing due to the advent of the personal computer (PC). The combination of increasingly sophisticated PCs and the abundance of concomitant software support can significantly augment the communicator's ability to manage his system better. With the aid of a computer, he can more readily contribute to the design and analysis of his node, relying on the computer to provide the answers to detailed, tedious, repetitive engineering procedures while he contributes the crucial parameters of human judgment and decision.

The task is to develop an algorithm, through several levels of refinement, that would be the basis for a computer program to predict levels of interference in a cosite configuration for single-channel and frequency-hopping systems. Minimal design requirements should include, but not be limited to, the following characteristics:

- (1) use of algorithmic language
- (2) design modularity
- (3) hierarchical design
- (4) uniformity:
  - (a) modules should perform specific functions
  - (b) variables have singular meanings
  - (c) variables values are of fixed range
- (5) good documentation:
  - (a) HIPO diagrams
  - (b) structured/N.S. flowcharts

Further activity in this project would be the construction and verification of an actual software program.

**N85-13. TITLE: Independent Validation and Verification of Tactical Air Operations Central-'85 Software**

**CATEGORY: Management and Support**

**DESCRIPTION:** The Tactical Air Operations Central-1985 (TAOC-85) Engineering Development Model (EDM) software/firmware is baselined to 1979-1980 military documentation standards. An independent validation and verification plan detailing documentation standards and software functions is required in transitioning the EDM software to a production software baseline. As a minimum, this plan should specify the organization of software validation and verification personnel, to include personnel validation and verification responsibilities. The procedures for validating and verifying specified software functions should be listed in detail.

Software program configuration identification procedures to include listings of functional, allocated, and product baseline documents, should be provided. Procedures detailing the review of these baseline documents should also be included in the plan. Software code library, software documentation library, and software test library organization and catalog procedures should be provided for in the validation and verification plan. Any other validation or verification information or procedures relating to successful transition of software programs from a developmental to a production baseline should also be provided.

**N85-14. TITLE: Lightweight Handheld Electronic Counter Countermeasures (ECCM) Communications Device**

**CATEGORY: Engineering Development**

**DESCRIPTION:** Current handheld radios do not include ECCM in any form that addresses a spread spectrum capability. In present and future areas of rapid information exchange with the required quick responses by echelons of Command, units must be equipped with a more effective means of transmitting and receiving digital data and voice information. The Marine Corps AN/PRC-68 handheld VHF/FM radio, although including encryption, could include ECCM by modification of the encryption logic and synthesizer, and changing the present channel selection to a broadband characteristic. A combination of pseudo random and frequency-hopping, spread-spectrum modulation would be addressed to include a margin of low probability of intercept (LPI) and ECCM. The mode of operation would be selectable between LPI/ECCM and the existent mode of operation.

**N85-15. TITLE: Tactical Warfare Simulation Evaluation Analysis System/Marine Integrated Fire and Air Support System Interface**

**CATEGORY: Advanced Development**

**DESCRIPTION:** Produce an Interface Design Specification, in accordance with Military Standard 1679 (or current version thereof), and an operational

concept of employment for the interfacing of the Tactical Warfare Simulation Evaluation Analysis System (TWSEAS) and the Marine Integrated Fire and Air Support System (MIFASS).

The TWSEAS is a computer-assisted, real-time tactical exercise control system which can monitor actual events as they occur in field exercises (FEX) and as reported by umpires using digital communications links. In the command post exercise (CPX), where only the player's command post is real, TWSEAS simulates the battlefield environment, reports the actions of all simulated units and calculates/reports all combat damage as a result of actions of forces on both sides of the engagement. In order to be successful, combat information must reach the player's command post in a manner which is the same as, or at least very close to, that which is present during actual battle. The TWSEAS must interact with the player's command and control (C<sup>2</sup>) systems. In the near future, this C<sup>2</sup> environment will include the MIFASS. MIFASS will be a C<sup>2</sup> system which will integrate artillery, mortars, naval gunfire and air support with the unit scheme of maneuver. As supporting arms actions form a large part of the combat/exercise environment, there is a clear need for the TWSEAS and MIFASS to interface.

This effort shall include the software and hardware issues involved in the interface, as well as an analysis of the level of interface required (i.e., manual, semi-automatic or automatic). This analysis should be supported by the operational and training requirements present during an integrated (i.e., combined FEX/CPX) exercise involving Marine Air Ground Task Forces (MAGTF) at all three levels of command (Marine Amphibious Unit, Brigade, and Force). These requirements include the need to present various information to the exercising staff via these C<sup>2</sup> systems, as well as the need to create a realistic combat environment through the simulation of the player's real world C<sup>2</sup> systems.

N85-16. TITLE: Tactical Warfare Simulation Evaluation Analysis System/Aviation System Interface

CATEGORY: Advanced Development

DESCRIPTION: Produce a report indicating the most effective means of interfacing the Tactical Warfare Simulation Evaluation Analysis System (TWSEAS) with the current and projected Marine Air Wing (MAW) command and control (C<sup>2</sup>) systems at the Marine Amphibious Brigade and Force (MAB, MAF) levels. Complicating this problem is the fact that the MAW command and control systems are already largely automated. The goal of this interface is to provide exercise information to the MAW command elements which will allow them to participate in integrated exercises with the other elements of the MAB and MAF.

The TWSEAS is a computer-assisted, real-time tactical exercise control system which can monitor actual events as they occur in field exercises (FEX) and as reported by umpires using digital communications links. In the command post exercise (CPX) where only the player's command post is real, TWSEAS simulates the battlefield environment, reports the actions of all simulated

units and calculates/reports all combat damage as a result of actions of forces on both sides of the engagement. In order to be successful, combat information must reach the player's command post in a manner which is the same as, or at least very close to, that which is present during actual battle.

The MAW C<sup>2</sup> environment contains numerous automated systems with new versions currently being developed. These systems include the Tactical Air Command Central Product Improvement Program (TACC PIP), the aviation portion of the Tactical Combat Operations (TCO) System and the Tactical Air Operations Central-1985 (TAOC-85). While TWSEAS does simulate individual flights of aircraft, the training target elements in the MAW are not so much the air controllers but, rather, the command staffs.

This effort should include an analysis of the most beneficial point(s) of interface to support the exercise training objective (i.e., to exercise the MAW command elements). Factors such as the amount and type of required information, the rate of transfer of this information, and appropriate transfer points shall be included. As a follow-on effort, Interface Design Specifications could be prepared for the specific interfaces defined in the initial effort. These specifications shall be in accordance with Military Standard 1679 (or current version thereof).

N85-17. TITLE: Marine Tactical Command and Control System (MTACCS) Planning Support System

CATEGORY: Management and Support

DESCRIPTION: The automation of command and control functions by systems in the Marine Tactical Command and Control System will create a complex task and system interface structure. A planning support system is needed to assist systems planners in recognizing interoperability requirements, task allocations, information exchange, and system dependencies. In addition, data must be maintained on command and control system physical interfaces for communications, networking, power, and peripherals. The planning system should be able to provide development/operational status of tasks and interfaces. Information provided by the planning system will assist in targeting task changes, adding new tasks, and assessing both logical and physical interfaces of Marine Corps Tactical Command and Control Systems.

The planning system should be a microcomputer-based data base system that provides a user-friendly interface for system planners. In addition, simple procedures should be provided to maintain and update the data base. The system should be planned to support information tasks and interfaces of the Marine Integrated Fire and Air Support System (MIFASS), Tactical Air Operations Central-1985 (TAOC-85), Position Location Reporting System (PLRS), Tactical Combat Operations (TCO) System, Marine Air Ground Intelligence System (MAGIS), and Tactical Warfare Simulation Evaluation Analysis System (TWSEAS).

**N85-18. TITLE: Implementation of Lightweight Combat Terminal (LCT) Requirements in Commercial Equipment**

**CATEGORY: Exploratory Development**

**DESCRIPTION:** A set of requirements and an initial functional specification for the LCT have been developed. These requirements and the specification identify the need for a general-purpose, lightweight computer for use at the battalion level. This device would be used to fulfill the requirements in a variety of functional areas, most notably fire support, intelligence, planning, operations, logistics, communications, and air defense. This "generic" device must be capable of being rapidly reprogrammed to meet different functional area requirements. Capabilities to be included consist of word processing, message editing and processing, graphics, display of maps and tactical information, data base management and query, and the capability to interface with printers and plotters to produce permanent copy. The device requires sufficient computing capability and storage to permit stand-alone processing in support of technical analysis, such as communications frequency allocation. The device should meet full military standards, be reliable, and capable of being interfaced with other Marine Corps Tactical Command and Control System (MTACCS) subsystems, such as the Marine Integrated Fire and Air Support System (MIFASS) and the Tactical Combat Operations (TCO) System.

Commercial computer equipment development appears to have reached a stage of ruggedness, reliability, and capability whereby many of the above requirements can be met. What is required is the development of a prototype LCT that would demonstrate the basic capabilities mentioned above using "off-the-shelf" computer equipment that is both ruggedized enough for general field use, but portable enough to be carried easily by one man. The effort should initially focus on the development of a prototype LCT that is capable of performing some, or all, of the operational functions specified in the current documentation. The prototype would then be demonstrated to Marine Corps field units to verify/validate the functional and operational requirements.

**N85-19. TITLE: Optimum Equipment Configuration for Marine Integrated Fire and Air Support System/Tactical Combat Operations**

**CATEGORY: Advanced Development**

**DESCRIPTION:** The current development strategy for the Tactical Combat Operations (TCO) System calls for TCO to be integrated with the Marine Integrated Fire and Air Support System (MIFASS). It is envisioned that TCO will be a software preplanned product improvement (P3I) effort to MIFASS.

Under the previous development strategy, where TCO was envisioned as using MIFASS-developed equipment but existing as a separate system, the necessary suite of equipment was identified and is documented in the TCO level-A (functional) specification, the System Description Document (SDD), and other technical notes and engineering studies. The new development strategy will require that the additional equipment necessary to support the identified

TCO functions be added to the MIFASS suite instead of purchasing an entirely separate suite of equipment for TCO. This addition of equipment will affect various system parameters of MIFASS, such as additional memory required to support both MIFASS and TCO, additional processing power needed, system throughput, etc.

What is needed is an analysis to identify the mix of equipment that must be added to the planned MIFASS suite to support the currently defined TCO functions at all levels of command in the Marine Amphibious Force. Also required is an impact analysis to determine the effect of adding this additional equipment on MIFASS as it is currently described in its specification, system description document, and other pertinent documentation.

N85-20. TITLE: Extended Range Ship-to-Shore VHF Multi-Channel Communications Feasibility and Equipment Identification

CATEGORY: Advanced Development

DESCRIPTION: Amphibious Forces Ashore must maintain reliable communications with Amphibious Shipping over 50 to 100 nautical mile ranges. Current VHF Systems cannot accomplish this. The tasks are:

1. Determine the feasibility of using specially designed auto-positioned-directional active array antenna systems to maintain links over the specified ranges in conjunction with sensitive receiver(s) with adaptive radio features (i.e., channel evaluation, automatic link establishment, etc.) and high-powered transmission capability continuously controllable.

2. Identify systems capable of doing the job, systems that can be modified to do the job and/or what it will take (money and time) to do the job.

The ship mode, as well as the shore mode, must be capable of operating in the 30 - 88 MHz frequency range restricted to the use of 25 kHz bandwidth and providing four 2.4 kHz digital channels capable of passing narrowband secure voice, data, and record traffic.

N85-21. TITLE: C<sup>3</sup>I Basic Research In Mathematics

CATEGORY: Research

DESCRIPTION: The mission of NAVELEX includes system development in Navy command, control, and communications, and undersea surveillance. Basic research in mathematics can support this mission. Example projects could include development of a new algorithm for undersea surveillance, mathematic research that can prove communication network design or can improve capability to transmit voice to submarines, or artificial intelligence (AI) approaches that can support command control, such as AI used in a self-contained situation assessment capability for lower echelon commanders. Projects are requested (not limited to these examples) that can aid the NAVELEX mission through more basic research projects in mathematics.

N85-22. TITLE: Situation Assessment

CATEGORY: Research

DESCRIPTION: Work is underway in the Navy to develop command centers for the top echelons of the Navy Command. The intent of this effort is to develop situation assessment devices, using small computers, for a lower level of command; e.g., the commander of a small ship. The situation assessment capability could aid the commander in, for instance, interpreting radar images or conflicting weather information. The situation assessment device could utilize AI, have some limited learning capability, and be interactive with the user.

N85-23. TITLE: Spare Part Serial Tracking

CATEGORY: Engineering Development

DESCRIPTION: Serial Tracking of entire populations or samples of populations of spare parts has been established as the prerequisite for decisions upon "repair or replace" at specific levels of the work breakdown structure for equipment. Methods are required which permit serial tracking with a minimum involvement of human effort wherever repairs are conducted and repair and maintenance cost arise.

The information shall be used to develop families with "similar behavior" in regard to maintenance and repair requirements. This, in turn, will be the basis for a decision logic, designed to answer specific questions with a tailored data base.

The result of this research will reduce the cost of data acquisition for spare parts and, at the same time, increase the accuracy for data as used presently in different data management systems of spare parts.

N85-24. TITLE: Laser Protection Eyewear

CATEGORY: Exploratory Development

DESCRIPTION: It is necessary to develop inexpensive glasses to protect Navy and Marine Corps personnel from eye damage when performing missions in or around lasers. Since these lasers will be tunable and cover several different frequencies, it is desirable to have a device that is not fixed to work at a single frequency. Also, it is desirable that the lens not interfere with normal vision to any great extent.



**N85-25. TITLE: High Frequency, Frequency Shift/Phase Shift Performance Investigation**

**CATEGORY: Exploratory Development**

**DESCRIPTION:** High Frequency Communication suffers in performance due to the time varying nature of the Communication Channel. The primary causative agents are the multiplicity of propagation paths and modes. If one assigns bit error rate (BER) for a given input signal-to-noise ratio (S/N) as a performance measure, then the desired objective should be to minimize the output BER for a given input S/N. One method of controlling the BER is by appropriate error control coding.

The objective of this task is to compare the relative efficiency of existing error control coding schemes, given the above performance measure, when applied to acceptable time delays and Data Terminal Set (MODEM) as are inherent in Link 11 (TADL A).

**N85-26. TITLE: ELF On-Hull Antenna for Submarines**

**CATEGORY: Exploratory Development**

**DESCRIPTION:** A decade ago, limited analyses and experimental data indicated that the design of an ELF antenna on the hull of a submarine has insurmountable difficulties. With the advance in the measurement techniques, signal processing, and computer technology, a feasibility study may well establish the foundation for the design of such an antenna by adaptive noise cancellation methods. With renewed interest in the ELF system, a hull-mounted antenna has many advantages over the long line antenna in tow.

**N85-27. TITLE: Detectability of Acoustic Emission in Underwater Communication**

**CATEGORY: Exploratory Development**

**DESCRIPTION:** Submarines prefer to operate in a passive mode without any acoustic emission other than own ship noise and flow noise which cannot be totally eliminated. This attitude or tradition tends to deny all means of underwater communication by acoustics. Progress in acoustic communication has been made in waveform design, coding, and signal processing which greatly reduces the probability for the source to be discovered. With those modern techniques, judicious use of underwater acoustic communication may not necessarily subject the submarine to a greater detectability than that caused by noise generated by the sub. In certain scenarios, a quantitative assessment to the increased risk provides a trade-off to determine whether the benefit to communicate outweighs the additional risk or not. Only an objective evaluation can provide the guidelines for the design of acoustic communication system and can convince the submariners that acoustic communication has its operational value when the situation, scenario, mission, and environment are suitable.

N85-28. TITLE: Jamming Detector

CATEGORY: Exploratory Development

DESCRIPTION: There is a need for a system to monitor radio communications circuits and to indicate when the received signal is corrupted with intentional jamming or other energy. The system may compare the received signal with known characteristics of the transmitted signal to make this determination. It should be applicable across many type signal modulation formats and across a wide range of frequencies. The techniques used should be robust to jamming signals designed to defeat the system and it should be simple and reliable in design and operation.

N85-29. TITLE: Multi-level Security for Local Area Network

CATEGORY: Exploratory Development

DESCRIPTION: Techniques are sought to handle multi-level security on distributed processing local area networks shared by many users. Demonstration implementations will be required on one of our generic local area networks (Ethernet/Token Ring/Broadband) located in one of our secure testbeds.

N85-30. TITLE: Satellite Surveillance and Countermeasures

CATEGORY: Exploratory Development

DESCRIPTION: Develop innovative approaches and new technologies in the areas of Satellite Surveillance Countermeasures and defense. Technologies encompassed include, but are not limited to, microwave electronics, electro-optical, space electronics and multisensor correlation processing. Applications range from satellite/shipboard sensor and countermeasure systems to support Naval objectives in worldwide ocean surveillance and targeting.

N85-31. TITLE: Cost-Effective Operational Satellite Packet Network Terminal

CATEGORY: Engineering Development

DESCRIPTION: The introduction of satellite packet networks will ensure that the Navy's communications assets at UHF/SHF/EHF are used in the most appropriate and efficient manner. A packet network will substantially decrease the transmission delay of a message compared to other techniques for certain types of traffic. The capacity of the satellite is dynamically allocated, using reservation and contention with the allocation process embodied in network protocols. The packet feature is independent of and will be added on top of existing access schemes. A modular cost-effective terminal suitable for shipboard use is needed that can serve as the basis for future Navy satellite packet networks.

**N85-32. TITLE: Data Bus Technology/Application Study**

**CATEGORY: Advanced Development**

**DESCRIPTION:** Data busses are a military necessity in many diverse and expanding applications. The technology has wide interest at the Federal, national (civil), and international levels (both civil and NATO). A survey is required to: (1) identify those organizations involved in developing and/or applying this technology; (2) determine the extent of data bus standardization for various applications; (3) determine trends in technology; (4) identify advantages (including estimated cost savings) and disadvantages experienced with different media, media access techniques, topologies, signal techniques or other technical characteristics identified as peculiar to data bus technology; and (5) summarize for reference the results of the survey.

Experience and professional competency in military electronic/weapons systems, technical/engineering assessment capabilities, and digital/analog telecommunications are essential. Additionally, technical/engineering survey techniques, data collection/analysis, and study report capabilities are required.

**N85-33. TITLE: VLF Transmit Antenna Design**

**CATEGORY: Exploratory Development**

**DESCRIPTION:** A transport VLF (25-30 kHz) transmit system is being defined. The radiating element would be either the 3,000-foot tether of a tethered aerostat or a top-loaded (12 radial top hat) 1,000-foot tower. The design may be applicable to either radiating element, but application to both is preferred. Design work is required to achieve an antenna efficiency of twenty percent or better, assuming a 0.0001 mho/meter ground conductivity. The hardware, including any necessary support equipment, must be reasonably transportable. The desirable features of the design are related to restrictions on site selection, installation time and crew size required for installation. Site selection restrictions imposed by a conventional ground plane may be used as a baseline for comparison. Installation in five days by a crew of ten people can be used as nominal upper limits for acceptability.

Experience with VLF antenna theory and design is required. Mechanical design of the aerostat or tower is not required. There is a potential for innovative designs which could deviate both from the standard radial wire ground plane design and the customary deployment techniques. Emphasis is placed on feasibility and practicality for transportable applications.

**N85-34. TITLE: Small System Applications for SSN Communications**

**CATEGORY: Advanced Development**

**DESCRIPTION:** A technology assessment is required to investigate state-of-art data bus architectures for small systems applications and determine applicability of different architectures to submarine exterior communications.

The investigation of submarine communications system display requirements will assess applicability of video displays to the submarine exterior communications system for system status, system configuration, operator aids, etc.

N85-35. TITLE: Cost Production Technique for Software

CATEGORY: Engineering Development

DESCRIPTION: The programs now available for predicting the cost of software programs are predicted on the ability to size the program. Unless the predictor has worked on a similar program, it is very difficult and sometimes impossible to predict the size and cost of software programs for a new development. Some thought and study should be directed to determine if there are other critical parameters that could be used to size a program. One approach could use the Type A specification for a given system as the baseline document for such a study.

If such tools could be developed, they could supplement such systems as Software Life Cycle Model (SLIM) which is now available. Effective use of SLIM requires accurate program sizing. Consideration in such a study should be given to program size, complexity, and architecture, as well as test and evaluation. There may be other factors that also should be considered. Organization should involve: first, a study phase which includes a literature search, review of other work, and visits; report of investigation, followed by a formulation phase for the approach; and the final phase, the preparation, and development of a final product. The final product could be a set of tools, probably software tapes used to predict initial cost, and then form the basis for a tracking system to track cost on the software system developed.

N85-36. TITLE: LO<sub>2</sub>/LN<sub>2</sub> Production Components

CATEGORY: Exploratory Development

DESCRIPTION: Cryogenic liquifiers in use by the Navy for shipboard LO<sub>2</sub> and LN<sub>2</sub> production employ high-speed turboexpanders operating on oil-lubricated bearings. Mechanical shaft seals with buffer gas stages are employed to prevent lubricant leakage and resultant contamination of the process gas. Successful continuous operation of the turboexpanders, and the liquifier system as a whole, depends upon the integrity of the turboexpander shaft seals, and on reliability of the oil lubrication pump and filtering system. Oil contamination from leaking seals and interruption of the turboexpander bearing oil supply occurs frequently in operation, resulting in extensive system downtime and related high maintenance costs. The Navy needs replacement components for the turboexpander/bearing system which are highly reliable in operation, and which will eliminate the potential for contamination of the product gases inherent in the present hardware.

N85-37. TITLE: Voice Recognition/Synthesis Technology

CATEGORY: Exploratory Development

DESCRIPTION: Based on current/projected state-of-the-art technology in the area of voice recognition/synthesis, develop concepts for the practical application of this technology to shipboard tactical command and control and command support functions. Concept development should include definition of performance capabilities (vocabulary, error rate, training requirements, etc.), man-machine interaction aspects, and application-specific operational benefits analyses.

N85-38. TITLE: Arctic Ice Excitation Technology

CATEGORY: Exploratory Development

DESCRIPTION: Develop concepts, methods, and technologies for direct and indirect excitation of localized regions of arctic ice sheets over a broad range of frequencies. The technologies are aimed at generating nondestructive acoustic/seismic signals that will be coupled by the ice sheet to the under ice sea water. Examples of candidate technologies are remote laser sources and deployed sonobuoy-like devices that can be placed in the ice sheet.

N85-39. TITLE: Small Craft Flotation Foam

CATEGORY: Engineering Development

DESCRIPTION: The Navy currently uses 2#/cu. ft. closed cell polyurethane foam for small craft flotation. The foam has several problems: it absorbs water over time; it becomes brittle with age; it expands with age; and when it burns, it releases toxic gas. The Navy is interested in obtaining a new closed cell foam with the following characteristics: in general, meets MIL-P-21929; is durable; has an approximate density of 1#/cu. ft.; can be poured in place; will not sustain combustion; does not release toxic gas when burnt; has low water absorption characteristics; and is inexpensive.

N85-40. TITLE: Low Cost Expendable Fuel Tanks for Carrier Aircraft

CATEGORY: Exploratory Development

DESCRIPTION: In order to provide increased tactical range and/or endurance, most Navy aircraft are equipped to carry auxiliary fuel tanks on selected external weapon stations. These tanks attach to the bomb rack and can be jettisoned using the normal bomb release system. Jettisoning is an exceptional event, occurring only when necessary to increase aircraft combat maneuverability or reduce aircraft weight and drag in an emergency. Auxiliary tanks normally remain on the aircraft throughout a mission. An auxiliary fuel tank is a cylindrical metal container with conical ends to improve aerodynamic shape. The fineness ratio (diameter/length) is typically about 15%. Interior plumbing is provided to permit the introduction of low pressure air which is used to force fuel through a feedline to the aircraft interior tankage. The

attachment points to the aircraft are two standard bomb lugs spaced either 14" or 30" apart which bracket the tank center of gravity. These are mounted in a strongback structure at the top of the tank which also supports air and fuel connections to mating connectors in the weapon station. The strongback structure also provides a bearing surface for the rack ejector foot as the tank is jettisoned. Currently, tanks are of welded aluminum construction and are delivered to the user fully assembled. Current tank capacities range from 150 to 650 gallons. Auxiliary fuel tanks present a severe logistics problem. For newer aircraft, they tend to be aircraft unique. While peacetime tank utilization is low, it can be expected that jettison rates in a combat environment will be high, necessitating the storage of large numbers of completely assembled spare tanks aboard ship. Combat demand is projected to be so high that carrier aircraft deck loads may be severely stressed to provide space for spare tank requirements. Finally, present tanks are excessively costly. There is a need for a standardized low-cost auxiliary tank in the 300-400 gallon range which can be delivered disassembled and stored aboard ship at high density in a nested configuration. Assembly of the tank aboard ship by relatively unskilled personnel should be accomplished in less than two hours. The assembled tank must have a structural integrity equal to current all-welded tanks. In particular, mechanical joints must remain secure and leakproof under the axial loads imposed by catapult launch and arrest and the normal loads imposed by aircraft maneuvering. These criteria must be met whether the tank is pressurized (transferring fuel at 4-6 psi overpressure) or unpressurized. Cost, weight, safety and tank standardization are all important considerations. Alternative structural materials (e.g., carbon filament composites) should be investigated. Information should be presented to document tank capacity, cost, structural strength, reliability and ease of assembly.

N85-41. TITLE: High-Speed, Digital Output Engineering Drawing Printers

CATEGORY: Exploratory Development

DESCRIPTION: The Army, Air Force and Navy are all actively pursuing development of digital mass storage systems for technical data. These efforts are running concurrently with industry development of the optical disk mass storage concept. Methods of output currently available for producing data retained in digital storage include:

- o electronic page printing systems
- o electrostatic plotters
- o pen plotters
- o computer output microfilm
- o telecommunications

A significant portion of the requirement in technical data management is the high volume production of engineering drawings up to 30" by 40". This is particularly true in spare parts procurement where many procurement actions at an Inventory Control Point are responded to by many bidders creating a need for thousands of engineering drawings per day. High volume production of these documents in a cost and time-effective manner from digital storage is

not available in today's market. A method of producing these documents in full-size format on paper as well as 35mm microfilm mounted on aperture cards is required.

N85-42. TITLE: Seaworthy Syrup/Cup-Type Soda Vending Machine

CATEGORY: Advanced Development

DESCRIPTION: Over the last ten years, "syrup" or "cup" type soda vending machines have virtually disappeared from use on board ship and have been replaced by can-type machines. The problem with the use of can-type machines is the amount of valuable storage space on board ship which must be used to store the cans that go into the machines. Five gallons of syrup can provide as many drinks as approximately 20 cases of cans while requiring only a fraction of the storage space. However, the "syrup" or "cup" type machines also have problems. The cup often spills when being filled when the ship pitches or rolls as does the refrigeration bath used for cooling. This type of machine has more working parts and is more difficult to maintain. Additionally, a poorly proportioned mixture is often provided resulting in customer dissatisfaction. What is needed is the development of a "seaworthy" vending technology that eliminates spilling, utilizes the space-saving advantage of "syrup" type machines and provides a consistent quality dispensed beverage.

N85-43. TITLE: Repair Kit for Navy Chemical Warfare Protective Overgarment

CATEGORY: Advanced Development

DESCRIPTION: A kit is required to provide means for repairing small tears (three inches long or less) to an 85/15 modacrylic/nylon outer shell material used in the U.S. Navy chemical warfare protective overgarment. Ideally, the repairs would be made with an adhesive-based patch which could be applied directly over the tear without the use of heat and with no compromise to chemical agent protection. The adhesive should provide sufficient adhesion resistance to prevent separation of the patch from the cloth under shipboard wearing conditions and also when wet.

N85-44. TITLE: Liquid Impermeable/Water Vapor Permeable Material

CATEGORY: Exploratory Development

DESCRIPTION: The Navy has a need for flame retardant material for use in the manufacture of chemical warfare protective garments that, in addition to possessing a high water vapor permeability index, would provide chemical agent protection under wet and dry conditions, including wind-driven salt and rain water and also against the impact of high-velocity chemical agent droplets. A minimum ten-year shelf life will also be required.

N85-45. TITLE: Traction Soles and Heels for Use on Wet and Oily Surfaces

CATEGORY: Exploratory Development

DESCRIPTION: Appropriate sole and heel materials are required to enhance slip resistance of footwear that is worn by Naval personnel working on smooth, wet and/or oily metal shipboard surfaces.

N85-46. TITLE: Optical Clear Facepiece for Pyrotechnic Hood

CATEGORY: Exploratory Development

DESCRIPTION: Develop an inexpensive, optically-clear plastic facepiece measuring approximately 14 inches by 8 1/4 inches with a 4 3/8 inch radius that could be used in the pyrotechnic hood conforming to NCTRF/PD 6183, used to protect the wearer from accidental "flash-off" of pyrotechnic material. The facepiece should be capable of protecting the face from feeling pain when exposed to a 5500°F thermal blast for a minimum of five seconds, and the optical properties of the facepiece should not be significantly degraded as a result of the thermal blast.

N85-47. TITLE: Fire Retardant Foam-In-Place Cushioning Foam

CATEGORY: Exploratory Development

DESCRIPTION: Approximately 100 Navy ships are equipped with foam-in-place packaging systems. The system provides a form-fit cushioning foam for the protection of items to be stowed aboard ships until off-loaded. The foam is generated by combining two chemicals under pressure at a fixed rate at room temperature with the resulting composition sprayed into a fiberboard box to protect a delicate item. The resulting foam is flammable and will contribute to the propagation of a fire ignited from other sources. In order to comply with the criteria established for the Shipboard Passive Fire Protection Program, an improved cushioning foam is required that is nonflammable or fire retardant upon generation and is compatible with existing foam-in-place systems.

N85-48. TITLE: Fire Retardant Treatment of Paperboard Materials

CATEGORY: Exploratory Development

DESCRIPTION: Paperboard materials and cartons are commonly used for the protection of supply items stowed aboard ship. These materials are flammable and will contribute to the propagation of a fire ignited from other sources. In order to comply with the criteria established for the Shipboard Passive Fire Protection Program, a fire retardant chemical treatment is needed to render paperboard materials and cartons used for packaging fire resistant or noncombustible. These materials are necessary to be consistent with nonflammable cushioning materials currently available and under development.



**N85-49. TITLE: Computer-Aided Instruction for the Navy Occupational Health Information Monitoring System**

**CATEGORY: Engineering Development**

**DESCRIPTION:** A Navy Occupational Health Information Monitoring System (NOHIMS) is being developed for collecting, processing, and displaying medical and environmental data for use in occupational illness and accident prevention programs. As part of the acquisition and installation process, the NOHIMS effort requires that a computer-aided instruction module be developed to train functional users on the operation of the system. This computer-aided information module may either be resident on NOHIMS or a separate stand-alone unit. Module documentation, including training materials, will be required.

**N85-50. TITLE: Naval Aviation Motivation Test Battery Development**

**CATEGORY: Advanced Development**

**DESCRIPTION:** Voluntary withdrawal of Aviation Officer Candidates, including pilots and Naval Flight Officers (NFOs), continues to account for about one-third of all attrition from naval flight training. While voluntary withdrawal from Navy Undergraduate Pilot Training is multifaceted, lack of motivation to continue training is the primary reason for such withdrawal. Motivational theory, literature, and tests exist which could (with suitable extension or adaption for aviation usage) account for and predict those who voluntarily attrite from training. The purpose of this research is to: (1) review and report upon human motivation theory, literature, and tests applicable to the selection of Aviation Officer Candidates (pilots and NFOs) for the purpose of completing training within Schools' Command; (2) develop improved methods and procedures for determining and validating reasons for withdrawing from training within Schools; and (3) develop and objectively administer and score automated motivational test battery(ies) for predicting withdrawal of pilot and NFO Aviation Officer Candidates from Schools. Provide recommendations and proposal for administering motivation test battery to 800-1000 pilot and NFO Aviation Officer Candidates in Schools' Command and develop and validate prediction equation(s) for predicting motivational withdrawal award. The successful bidder must demonstrate detailed knowledge and understanding of Navy Undergraduate Pilot Training, motivational theory or literature and tests, and psychometric requirements for test development and validation.

**N85-51. TITLE: Measurement of Pulsed Microwave-Induced Acoustic Vibrations**

**CATEGORY: Exploratory Development**

**DESCRIPTION:** This effort concerns the measurement of waveform parameters (such as predominant frequency and amplitude) that are generated by thermoelastic expansion in three sizes of spherical head models that absorb pulsed microwave energy produced by multimegawatt radar transmitters. The approach, in general, uses the hardware assets of the Navy Aerospace Medical Research Laboratory combined with the technical know-how and scientific

expertise of the contractor. Miniature hydrophone transducers and brain-equivalent spherical models, along with microwave-anechoic irradiation chambers and radar transmitters that require final testing evaluation before use, will comprise the government-furnished equipment (GFE). The contractor must conduct trouble-shooting procedures and minor repair of the radar transmitters. The products of this effort include: (1) a tabulation of the operational characteristics of the laboratory-based radar transmitters; and (2) specific waveform-analysis data related to the acoustic properties of the microwave-induced vibrations in the spherical head models.

N85-52. TITLE: Microfilm and Computer Full-Text Search of Archival Documents

CATEGORY: Management and Support

DESCRIPTION: Microfilm, in chronological order, about one hundred thirty eight (138) cubic feet of a variety of unclassified historical archive documents and simultaneously catalog in an organized file system. Provide a retrieval file system software program for the Zenith 120 computer that will support search after input of key descriptors. Finally, enter sufficient predetermined descriptors in the software program to reference corresponding cataloged microfilmed archive documents. Commercially available software meeting search requirements should be given preference.

N85-53. TITLE: Use of Hydrogen as a Breathing Gas in Deep-Sea Diving

CATEGORY: Exploratory Development

DESCRIPTION: This effort is to determine the feasibility of using hydrogen as a breathing gas in diving. Currently, helium-oxygen mixtures are used in all deep-diving operations to alleviate the narcosis produced by breathing nitrogen. However, the world's supply of helium is decreasing. Based on its physical properties, hydrogen has been proposed as a substitute for helium, and some animal and human tests have been conducted in the U.S. and abroad. The initial task is to develop the rationale for the use of hydrogen in diving, and to compile information relative to past and current experimental efforts, especially those efforts being pursued in other countries. This task would determine the state-of-the-art and define current and future research and development needs. This would be followed in later phases by experimental studies to fill gaps in the technical knowledge required for use of hydrogen in human diving.

N85-54. TITLE: Automated Recognition of Helium Speech

CATEGORY: Advanced Development

DESCRIPTION: A mixture of helium and oxygen is the breathing mixture of choice for dives deeper than 200 feet. Because of the difference between this mixture and normal air, the frequency range of human speech is shifted upward. This has often been called the "Donald Duck Effect." This effect makes intelligible communications between the diver at depth and the controller on the surface difficult. Techniques exist for the automated

recognition of speech, or at least for the recognition of a set of well-defined words. This effort will be directed at defining those words which are necessary for communication between diver and controller, evaluating microprocessors for use in recognizing those words as spoken by a diver breathing a helium/oxygen mixture, and evaluating types of displays for communicating the recognized helium speech to the surface controller. Responders should have understanding and experience in the areas of automated speech recognition and human factors engineering.

N85-55. TITLE: Development of a Medical Dictionary and Training Materials for the Navy Outpatient Medical Information System (NOMIS)

CATEGORY: Advanced Development

DESCRIPTION: A Navy Outpatient Medical Information System (NOMIS) will be developed to collect, process, and display medical data for use in Navy outpatient clinics. A systems analysis must be conducted at representative clinics to determine information requirements of the clinics and to develop specifications for systems design. A comprehensive dictionary of data elements must be defined to standardize the outpatient medical record. Training material must be produced to support user needs. Concepts and plans are solicited for a study effort that would lead to development of a prototype data management system that is flexible, interactive and incorporates extensive user-assistance capabilities.

N85-56. TITLE: Development of Test Scenarios for the Navy Occupational Health Information Management System

CATEGORY: Engineering Development

DESCRIPTION: The Navy Occupational Health Information Management System is being developed to provide data storage and retrieval to meet the requirements of occupational safety and health. Test scenarios must be developed to exercise the various routines so that different system configurations can be compared and evaluated. These scenarios will allow the effects of factors, such as average CPU instruction cycle time and disk access time, to be determined and to estimate the average response time for the system simulating various types of clinical operations.

N85-57. TITLE: The Feasibility of a Nondestructive Method for Determination of Mass Distribution Parameters for Anatomical Segments of Nonhuman Primates

CATEGORY: Exploratory Development

DESCRIPTION: At high-energy levels (excess of 120 KEV) the absorption of materials becomes almost completely dependent on the total mass of material traversed by the energy. The exposure of animal body members to a radiation source in a known direction relative to the anatomy would allow for the determination of the mass distribution about the source axis. The exposure around a number of axes (greater than six) would theoretically allow for the determination of the parameters desired. The purpose of this study is to

determine the feasibility of using a high-energy radiation source (120 KEV or greater) to evaluate the mass, inertia tensor, and center of gravity of critical anatomical members of nonhuman primates. Phase I of the proposed work should establish, from theoretical considerations, the characteristics of the radiation source required and the expected accuracy inherent in the method. Calibration requirements should also be determined. Contractor must have access to a high-energy radiation source and availability of a phantom that simulates radiation cross-section of animal anatomical members.

N85-58. TITLE: Accelerator Prediction Program

CATEGORY: Exploratory Development

DESCRIPTION: Using analytically-determined acceleration setup parameters (i.e., load and cylinder volumes and pressures) develop acceleration prediction model(s) that will result in a family of acceleration-time profiles for metering pins associated with the 6-inch and 12-inch Hyge<sup>(R)</sup> impact accelerators. Determine metering pin profile along with accelerator setup parameters for a specified acceleration-time profile. Phase I of the proposed work will establish the feasibility of developing such models. Prospective bidders must have a demonstrated capability in fluid flow or mass transfer simulation, access to large computing facilities, and access to machinery operations for metering pin fabrication.

N85-59. TITLE: Fiber Optics Local Area Network Design

CATEGORY: Management and Support

DESCRIPTION: Develop a phased schedule approach for planning, budgeting, and installation of a fiber optics based local area network throughout NAVAIR operated space and to a larger area of concern being all Naval Material Command activities. Investigate and report on "secure" parameters required for such a network. Identify existing installations or proposed sites using fiber optics technology for digital computer communications.

N85-60. TITLE: Broadband HF Antenna Study

CATEGORY: Research and Exploratory Development

DESCRIPTION: Study the development of a broadband high-frequency antenna structure for the TACAMO airframe. The structure(s) should not degrade aerodynamic performance and should allow multiple transmitter inputs. Techniques for development should be evaluated with consideration of maximum efficiency and bandwidth, minimum losses, best indication of resistance, and minimum structural changes to the aircraft. The entire (2-30 MHz) must be considered.

**N85-61. TITLE: Molecular Structures for Avionics and Aviation Materials**

**CATEGORY: Exploratory Development**

**DESCRIPTION:** Recent advances in biology (genetic engineering, hybridoma, and immobilization of enzymes), chemistry (thin films and surface modification), and physics (electrical conduction by charge density waves) suggest possibilities for the manufacture and control of molecular structures of great diversity, complexity, and miniaturization.

The purpose of this program is to obtain relevant research and development on molecular structures for avionics and aviation materials. The R&D is expected to create and demonstrate an understanding of the opportunities and limitations in the building of molecular structures for use in computers, sensors, and electronic/optical magnetic devices. The program also addresses the novel use of biopolymer dynamics, in particular: electron handling, exciton, tunneling, Rydberg state, and semiconductor behavior. It is also recognized that multidimensional material matrices and associated structural and functional properties are of interest.

**N85-62. TITLE: Aeroelastically Tailored Controls for Missiles**

**CATEGORY: Research or Exploratory Development**

**DESCRIPTION:** Design a missile control surface, probably using composite materials, which will deform under load in such a way as to minimize chordwise variations in center of pressure. Fabricate a sample of the control surface and test it in a wind tunnel at supersonic speeds.

**N85-63. TITLE: Boundary Layer Calculations for Missile Configurations**

**CATEGORY: Research**

**DESCRIPTION:** To develop computational methods and prepare working transferable computer codes for 3-D boundary layer flow calculations about tactical missile configurations. Objective is to provide a method by which to determine the skin friction contribution to the total drag coefficient of a missile which may have air-breathing inlets and fins. At the same time, the methods developed should provide insight and physical understanding of the boundary layer flow properties and character, especially those relating to transition, separation, boundary layer interactions, and turbulence modeling. The methods should consider solutions to 3-D differential, as well as integral boundary layer equations, and make use of, and be coupled with, the existing inviscid code results. The investigation should also make use of the existing experimental information with an alternate objective to develop reliable means by which to interpolate and even extrapolate the existing experimental data base to flight conditions of interest.

N85-64. TITLE: Unified Symbolic and Numerical Processing for Airborne Surveillance

CATEGORY: Basic Research

DESCRIPTION: Develop innovative concepts for combined symbolic and numerical processing algorithms to enhance the mission effectiveness of the E-2C system through better support of the onboard operators. E-2C hardware and software enhancements, since the introduction of this system, have permitted complex target tracking calculations based on the mathematics of probability, detection, and estimation theory to be implemented. Recent advances in artificial intelligence have led to symbolic processing concepts which might have high payoff if used in conjunction with purely quantitative techniques to implement a unified mission support system to aid E-2C operators in detecting, tracking, sorting, assessing, and reporting targets to off-board data consumers. Planned future hardware upgrades will result in new architectures suitable for implementing advanced computational concepts. The objectives of this research are: to develop approaches to the naval airborne surveillance mission which use to best mutual advantage the capabilities of human operators, numerical calculations, and symbolic calculations; to determine specific algorithms, both quantitative and symbolic, as well as the executive function controlling both in support of the surveillance mission; and to demonstrate the feasibility and potential payoff of this approach to surveillance.

N85-65. TITLE: Aural Mine Detection and Classification

CATEGORY: Exploratory Development

DESCRIPTION: Develop innovative techniques for sonar signal processing for approximation of target size and orientation by use of aural processed signals. Limitation should be addressed as to discrimination between two targets located in same area, degradation with range, and effects of target size and composition.

N85-66. TITLE: Review of State-of-the-Art Sonar (10-30 kHz) Transducer Window Materials

CATEGORY: Engineering Development

DESCRIPTION: This task involves an investigation of new materials being used or being developed which may have applications as sound transparent sonar windows. The review should be directed at materials which could provide the lowest loss of sonar acoustic signals in the 10 to 30 kHz range as it travels through the material. Trade-offs of material thickness vs. strength vs. acoustic loss should be determined. Most sonar systems on ships have a window in front of the transducer which is part of the hull structure. A need for strength at the lowest loss in the transmitted signal is required.

N85-67. TITLE: PASCAL Compiler Optimization

CATEGORY: Engineering Development

DESCRIPTION: Provide an analysis that can be optimized to allow more complete coverage of PASCAL statements and speed up existing compiler capabilities.

N85-68. TITLE: Signature Testing of a General Purpose Computer

CATEGORY: Engineering Development

DESCRIPTION: The increasing complexity of logic design has made testing increasingly more difficult for sequential machines. The use of signature analysis in testing sequential machines may be a solution.

Develop a method to employ signature analysis in testing of any general purpose sequential machine. Identify methods to be used to identify any hardware augmentation required. Estimate of augmentation requirements, fault coverage, number of signatures and execution time shall be generated. The number of states of the machine shall be determined and the algorithm employed to generate the signatures shall be defined.

N85-69. TITLE: Application of Nonprocedural Languages to Embedded Weapon Systems Software Development

CATEGORY: Advanced Development

DESCRIPTION: Investigate the use of nonprocedural languages and techniques to automate and accelerate the development of applications for complex, real-time, embedded, distributed, micro-processor based environments. Consider as major constraints the need for high reliability in all systems operations, ease of operations, and periodic modifications of software components.

As a second phase, identify a nonprocedural language and a set of procedures that will serve as a framework for developing prototype tasks. Also, develop several prototype tasks to demonstrate feasibility.

N85-70. TITLE: TRIDENT Higher-Level Language Syntax Directed Editor

CATEGORY: Advanced Development

DESCRIPTION: The objective is to develop a text editor for the VAX computer that has the normal screen-oriented and line-oriented capabilities and can be run in a "program mode." In this mode, the editor will consider the text being edited as a program in the TRIDENT Higher-Level Language (THLL). The feasibility of building such a system on the basis of an existing editor and an existing compiler should be determined.

Some of the capabilities of the systems should be to allow the user to locate references to a symbol, the definition of a symbol, the beginnings and ends of bracketed constructs (block, IF, CASE, parenthesized expression) both of the current level or any enclosing level. Syntax errors should be reported while the program text is being developed.

N85-71. TITLE: The Automated Development of Test Cases for Large Real-Time Software Systems

CATEGORY: Research

DESCRIPTION: The objective of this research is to develop a methodology for the automated generation of test cases for large real-time software systems which are programmed in a block structured language. Current methodologies are applied only to small programs and do not take into consideration the combination of such programs into a large system.

Proposals are invited which apply existing technology to the systems concept, or propose new methodologies for accomplishing the task. Proposals are also invited which address interactive systems which aid the test case developer.

Proposals should address the task as a two-part effort: (1) the identification of a methodology; and (2) the actual implementation of a prototype model.

N85-72. TITLE: Automated Software Generation Systems for Large, Embedded Real-Time Software

CATEGORY: Research

DESCRIPTION: Major increases in productivity for development of software for large, embedded real-time computer systems can perhaps best be achieved through automation of the entire software development process. Such automation would require automatically transforming a specification of the problem statement to a computer code which represents the solution. The solution produced should satisfy some criteria for correctness. Research in this area should identify the processes and issues associated with this automated transformation and investigate the feasibility of producing the end result. Such issues to be addressed include the form of the requirements specification, analysis of requirements, transformation of requirements to code, correctness and reliability of the code, documentation produced, and any other factors identified.

N85-73. TITLE: Software Metrics for Large, Embedded Real-Time Software

CATEGORY: Research

DESCRIPTION: Management and development personnel of large, embedded real-time software efforts could benefit from the acquisition and use of the



appropriate software metrics. However, such metrics are seldom available and are impractical to obtain at the stage of development where they are most needed.

The goal of this research is to identify those metrics which can be most beneficial to the software development effort and to derive techniques for obtaining such metrics. Of particular interest are metrics which support subject management (cost, schedule, manpower, risk, etc.), software reliability, capacity management (performance analysis and planning) and software quality. The techniques for acquiring such metrics should pose the least additional burden on the development personnel and systems configuration. An investigation of how the metrics will be used by management and development personnel should be performed.

N85-74. TITLE: Corrosion Resistance Coating for Heat Transfer Surface

CATEGORY: Exploratory Development

DESCRIPTION: Development of high conductivity, high emissivity, galvanically compatible coatings for resistant thermal surfaces is needed.

N85-75. TITLE: Sensors

CATEGORY: Engineering Development

DESCRIPTION: Develop new sensors using specific potential, microconductivity, piezoelectric magnetometer, and temperature techniques for nonacoustic detection of undersea objects.

Develop submarine-mounted sensors for measuring surface thickness. A potential need exists for a reliable sensor that can be mounted on FBM and attack class submarines for accurately measuring the thickness of surface ice in northern patrol zones.

Develop sensors designed for improved oceanic current measuring techniques. Advanced sensors in this area would have a wide application ranging from more accurate measurement of fluid flow across the launch area of FBM submarines to passive detection of interval waves caused by submarines could be beneficial to improved accuracy program.

N85-76. TITLE: A Methodology for Measuring Data Coverage of Test Cases for Large Real-Time Software Systems

CATEGORY: Research

DESCRIPTION: The object of this research is to develop a method of measuring the effectiveness of test cases developed for large real-time software systems. The main area of concern is how well the test cases cover allowable data utilization. Specific areas of concern involve the testing of data tolerances, data stress testing, and iterative convergent testing.

Proposals which address only areas of currently well-defined methodologies, such as type conversion testing, etc., will not be accepted.

Proposals should be written so as to address the task as a two-part effort: (1) the development of a methodology; and (2) the implementation of a prototype.

N85-77. TITLE: Physical Oceanographic Measurements

CATEGORY: Engineering Development

DESCRIPTION: The objective of this effort is to study methods for the development of doppler velocimeters and nonmechanical devices to measure ocean current speed and direction. Devices are for use on surface ships which use deep ocean transponders to accurately determine ship's position. The effort includes a review of Acoustic Doppler Current Meter (ADCM) technology, assessment of the performance of the existing Navy and DOD devices, and appraisals of the state-of-the-art further developments.

N85-78. TITLE: Meteorological Instrumentation

CATEGORY: Engineering Development

DESCRIPTION: Perform studies relative to improved upper atmosphere sounding systems (Omega/LORAN SONDES) for measurement of high-altitude winds. Studies would include automation of data processing to reduce the manpower currently required.

N85-79. TITLE: Long-Term Material Properties of Epoxy Grout Systems

CATEGORY: Advanced Development

DESCRIPTION: Determine the material properties of epoxy grout (hardness and elasticity, and mechanical bond strengths) to substrates (e.g., steel) as a function of long-term cyclic loading and environmental exposures. The grout system is used to fill the annulus between two concentric, large diameter metallic tubes.

N85-80. TITLE: Nondestructive Inspection of Bonded Metallic/Elastomeric Interfaces

CATEGORY: Advanced Development

DESCRIPTION: Develop nondestructive inspection techniques to quantify the percentage and location of metallic/elastomeric interfaces that have become unbonded due to material failure of the bond joint and/or corrosion of the metallic substrate. Access is limited to the elastomeric member which is irregular/nonsymmetric in cross-section.

N85-81. TITLE: Extended Life and No Maintenance Slip Ring

CATEGORY: Engineering Development

DESCRIPTION: Conduct feasibility investigation (analysis/design/test) of the development of an extended life/no maintenance slip ring. It should contain about 30/32 transmission circuits; have an MTBF of about 25,000 hours continuous operation at about 0.25 RPS; should be about 0.5 inch in diameter and a 1.5 inch length; and circuit impedance less than 100 milliholms.

N85-82. TITLE: Expert Systems for Large, Embedded Real-Time Software

CATEGORY: Research

DESCRIPTION: Software development for large embedded computer systems is a complex process that could potentially benefit from the application of expert systems technology. The purpose of this research is to investigate the applicability of such technology to the software development process for this class of system.

Efforts should be directed toward approaches for constructing an "Intelligent Software Assistant" which will be capable of advising management and software development personnel on all aspects of software development including feasibility, risk, project progress, performance cost and other issues identified.

N85-83. TITLE: Real-Time, 3-D Computer Vision

CATEGORY: Exploratory Development

DESCRIPTION: Investigation passive machine vision concepts for use in robot, Computer-Aided Design/Computer-Aided Manufacturing (CAD/CAM), and other military applications that will provide range and classification of objects in three-dimensional space in real time (video frame rates).

N85-84. TITLE: Human Factors Related to Military Applications of Robots

CATEGORY: Exploratory Development

DESCRIPTION: Robots and other forms of flexible automation will plan an important role in extending the capabilities and improving the productivity of a limited military work force. It is extremely important that this equipment be carefully engineered to be compatible with the environment in which it will be operated.

Investigations are required that will lead to advanced man-machine interfaces that are well matched to the military personnel who will operate and support robotic devices. Such issues as human engineered controls, safety, training systems, maintenance and repair, diagnostics and other man-machine interface considerations should be investigated.

N85-85. TITLE: Power Sources for Robots

CATEGORY: Exploratory Development

DESCRIPTION: One of the major barriers to continuous autonomous operation of mobile robots for military applications is the inadequate performance of available power sources. Lightweight, long-term stable power is required for the operation of robot electronics. In addition, bursts of power are required for mobility, heavy lifting and other demanding mechanical functions. Power sources that can provide both of these capabilities over long periods of time and in a single lightweight package are of great interest.

Advanced power systems, including hybrid concepts that integrate available power sources, should be investigated to meet the needs for long-term, low-level robotic operations with surge capabilities for high-power demands.

N85-86. TITLE: Directed Energy Weapons, Weaponization Technology Development

CATEGORY: Exploratory Development

DESCRIPTION: Defense against antiship cruise missiles in the <10nmi zone requires the ability to engage multiple simultaneous targets with low radar cross-section and a variety of flight profiles. Trends toward low-altitude, high-speed saturation attacks launched from long-range places significant pressure on an engagement defense system. A technology that offers hope of making a revolutionary change in Anti-Air Warfare/Anti-Ship Missile Defense (AAW/ASMD) is Directed Energy Weapon (DEW).

Perform an investigation into and conduct an analysis of the technology areas necessary for weaponization of a DEW-type system. Determine areas which must be pursued in developing such a system from an AAW/ASMD standpoint. Investigate such parameters as pointing accuracies, pointing rates, reaction times, firing rates, and total shots required. Compare these with existing capabilities to determine technology areas that may need extensive development efforts.

N85-87. TITLE: Atmospheric Dispersion of Ordnance Products

CATEGORY: Exploratory Development

DESCRIPTION: The products formed by conventional explosive detonation, propellant burning, pyrotechnic functioning, and similar processes, enter the atmosphere and are dispersed by winds and atmospheric turbulence. A need exists to determine the downwind concentrations of these products by mathematical modeling. Several dispersion models are available for common forms of air pollution, but limited attention has been given to the special problems connected with ordnance testing and ordnance disposal.

N85-88. TITLE: Computer Model of Hot Spot Formation in Energetic Materials

CATEGORY: Research

DESCRIPTION: The task is to develop a computer model of the formation and growth of ignition sites in explosives and propellants that is both numerically accurate and phenomenologically correct. For many ignition scenarios, the energy deposited in the material is insufficient to cause reaction if the energy is deposited uniformly over the bulk of the material; yet, ignition occurs. This leads to the postulation of some mechanism of energy concentration into "hot spots." Many mechanisms have been postulated: pore collapse; adiabatic compression; shear banding; jetting; etc. The objective of this work would be to develop a model to accurately describe this phenomenon.

N85-89. TITLE: Advanced Damage Model Development

CATEGORY: Exploratory Development

DESCRIPTION: A need exists for the development of advanced models for predicting the damage inflicted on targets by air and/or underwater weapons. The task requires that finite element codes and models be upgraded to treat the following topics: large dynamic plastic deformation; perforation; erosion of penetrators; spalling; crack growth; fluid-structure interaction; and propagation of strong shock and detonation waves through several media. Not only are new capabilities added to the codes, but basic improvements in the codes themselves are made. These include modular architecture; numerically stable interfacing between the modules; efficient integration; and "user friendly" pre- and post-processing. Supporting experimental efforts to validate the models are planned in detail.

N85-90. TITLE: Acoustic Modeling

CATEGORY: Exploratory Development

DESCRIPTION: Develop a dedicated model for the dynamic response of a viscoelastic multilayered material using 3-D finite element methodology. The model must accurately describe the viscoelasticity of the problem and be capable of accepting cylindrical perforations in the layers. The computer code should be written in standard FORTRAN and predict the surface complex impedance and acoustic loss as a function of frequency for a harmonic input force.

N85-91. TITLE: Air-Free Kevlar/Urethane Composites

CATEGORY: Exploratory Development

DESCRIPTION: It is desired to construct an acoustically transparent Kevlar reinforced polyurethane composite. It is known that even small amounts of air in a composite can seriously degrade the transparency of such composites. The major difficulty arises when using large diameter Kevlar cords, 0.140 inches diameter, five ends per inch. In this case, the urethane does not fully

penetrate the cords, leaving some trapped air behind. Some way must be found to effect total impregnation of the cords in some manner that lends itself to economical manufacturing.

N85-92. TITLE: Electrically Conducting Polymers

CATEGORY: Research

DESCRIPTION: An electrically conducting polymer would be attractive because of the considerable weight savings that would result compared with copper. Polymers generally are electrical insulators (conducting less than  $10^{-8}$  mho), but certain highly conjugated systems (such as polyacetylenes) are conductors (conductivity greater than  $10^0$  mho). A disadvantage of these systems is that the same chemical structure that gives rise to the conductivity also makes these polymers very susceptible to oxidation. The goal of this project would be to develop a polymeric system with a conductivity greater than  $10^2$  mho but good oxidation resistance. The use of dopants would not be considered in this program.

N85-93. TITLE: High-Frequency Dynamic Mechanical Measurement Apparatus for Polymers

CATEGORY: Exploratory Development

DESCRIPTION: The measurement of the dynamic mechanical properties, modulus and loss factor, for polymers (plastics and rubber) is of continuing interest. Because of the broad relaxation ranges in these materials, measurements must be made over many decades of frequency to fully characterize the polymers. Present apparatus covers the frequency range from 10 Hz to 25 kHz. It is desired to extend these measurements to 100 kHz.

N85-94. TITLE: Three-Dimensional Braiding of Composite Materials Reinforcements

CATEGORY: Exploratory Development

DESCRIPTION: There is a need for research in innovative methods of three-dimensional braiding for composite reinforcements. Principally, the work will involve developing methods of implementing Adjacent Yarn Position Exchange (AYPEX), a new type of three-dimensional braiding. The emphasis will be on developing hand-operated braiders and using these to develop hybrid weaves which are combinations of 3-D orthogonal weaves and 3-D braids.

N85-95. TITLE: Development of Ceramic Foam Reinforcements

CATEGORY: Exploratory Development

DESCRIPTION: Proposals are sought to study and determine the applicability of ceramic foams as reinforcing media for metal-matrix composites. Foam structures can be fabricated with highly regular, uniform structural composition and, when infiltrated with matrix metal, could result in composite

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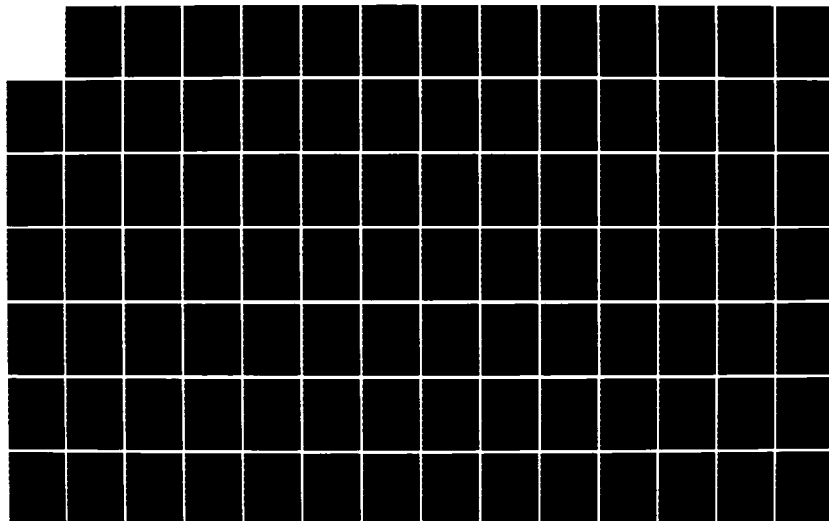
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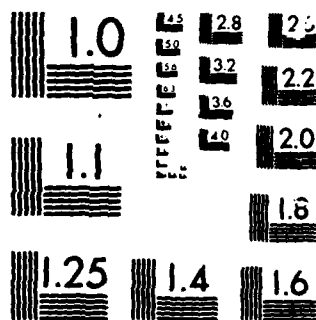
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materials with exceptionally uniform composition without the use of elaborate mixing and processing methods. It is necessary to identify ceramic foam characteristics in detail to define their suitability as reinforcements in metal and possibly ceramic matrices. Such aspects as foam architecture, porosity, shape of the ligands which constitute the foam, crystallite orientation, etc., need to be investigated.

N85-96. TITLE: Corrosion Behavior of Metal Matrix Composites in Hostile Environments

CATEGORY: Exploratory Development

DESCRIPTION: Proposals are sought to determine the corrosion behavior of various metal matrix composites in hostile environments such as salt spray, stack gases, etc. In addition, protective coating studies will be incorporated in the study to determine their effectiveness in inhibiting corrosion.

N85-97. TITLE: Preparation and Properties of Pure Synthetic Iron Pyrites, FeS<sub>2</sub>

CATEGORY: Research

DESCRIPTION: Iron pyrite, FeS<sub>2</sub>, derived from naturally-occurring mineral sources, is employed as the active cathode material in primary molten salt batteries (thermal batteries). The goal of this research program is to study synthetically-prepared FeS<sub>2</sub> as a substitute material for eliminating a serious voltage "spike" problem that occurs upon activation of thermal batteries and that is caused by impurities present in the naturally occurring cathode material.

N85-98. TITLE: Adhesive Bond Evaluation

CATEGORY: Research

DESCRIPTION: Nondestructive testing of adhesive joints is a problem which has plagued the nondestructive testing community for decades. Currently practiced ultrasonic techniques can often determine whether a bond has occurred, but the prediction of bond strength relies heavily on assumptions which are often unfounded. The reliability of such strength predictions might possibly be improved by a combination of an applied mechanical stress in conjunction with a nondestructive measurement. Development of practical means for both applying stresses and evaluating their effects on bond interfaces may provide a reliable means of assessing bond performance under actual loading.

N85-99. TITLE: Eddy Current Inspection of Graphite-Epoxy Composites

CATEGORY: Research

DESCRIPTION: Graphite-Epoxy composites are often used in environments which subject these materials to impact damage. Such damage often results in broken

or displaced fibers. Preliminary research has shown that eddy current testing may offer a suitable means of detecting hidden damage, yet many fundamental questions remain unanswered. A thorough understanding of the interrelationships between probe characteristics, frequency, penetration depth, damage position, damage type, damage size, and fiber density must be gained before eddy current testing of graphite composites can proceed to more advanced development.

N85-100. TITLE: Nondestructive Testing of Ordnance Items

CATEGORY: Exploratory Development

DESCRIPTION: The quality of ordnance related components directly affects their safety and reliability. Defects occurring in either manufacturing or long-term storage can easily escape detection, thus adding a degree of uncertainty in weapon performance. Principal areas of concern include voids in explosives, debonding of propellant from rocket motor cases and degradation of the mechanical properties of explosives and propellants. Innovative approaches in areas such as, but not limited to, ultrasonics or radiography may have bearing on the above problems.

N85-101. TITLE: Clutter Suppression Processing for Infrared Search and Track (IRST)

CATEGORY: Exploratory Development

DESCRIPTION: The pacing technical problem in IRST development is that of clutter discrimination for target declaration at useful ranges with acceptable false alarm rates. The essential element in achieving this goal is the development of optimum signal processing algorithms to exploit maximally the differences between targets and clutter backgrounds. A systematic approach for developing, evaluating and optimizing such algorithms is needed. This project is intended to redress this deficiency and will entail:

(1) application of appropriate mathematical formulations of classical detection theory for extracting signals from noise; (2) development of mathematical relationships which are applicable to signals embedded in nonstationary random processes; and (3) surveying and investigating existing IR clutter signal processing algorithms, developing new ones and optimizing the most promising of them. To perform these tasks, appropriate computer simulations will be developed and exercised.

N85-102. TITLE: Infrared Cloud/Sea Modeling and Underlying Fundamental Physics

CATEGORY: Exploratory Development

DESCRIPTION: This effort is in support of the Navy's Background Measurement and Analysis Program (BMAP). It is directed toward the development of engineering working models of infrared cloud and sea clutter models to be used in the evaluation and design of Infrared Search and Track (IRST) devices by means of system simulation. The eventual goal is the delivery of a documented computer code which can generate spatial and perhaps temporal clutter radiance

maps from experimental ground and air truth measurements taken during the background clutter data acquisition by the BMAP sensor. The underlying fundamental physics of cloud clutter dynamics is being sought which will lead to the development of superior models. Innovative mathematical physical approaches such as nonlinear dynamics, hydrodynamics, nucleation theory, metastable states and phase transition theory are suggested in part in this behalf. Simple laboratory demonstration cloud experiments are encouraged.

N85-103. TITLE: Numerical Algorithm for Predicting the Dynamics of Underwater Explosion Bubble

CATEGORY: Research

DESCRIPTION: Development of computational methods and numerical schemes which can accurately predict the evolution of the underwater explosion bubble and its interaction with structures. The ultimate objective is to develop such capabilities for general three-dimensional flow fields and configurations, accounting for such essential features as energy dissipation, bubble migration and deformation, etc.

N85-104. TITLE: Accelerometers, Longitudinal Strain Sensors and Torque Sensors

CATEGORY: Exploratory Development

DESCRIPTION: A new, cheap magnetoelastic metal has been developed at the Naval Surface Weapons Center that has the highest sensitivity ever known for torsional and longitudinal strain sensing. A highly sensitive torsional and longitudinal accelerometer model also exists. Low frequency response is excellent. The material can be used in its present ribbon form or can be possibly sputtered in a "chip-like" technology. Distributed arrays of miniature sensors can thus be developed. Such devices can impact on passive sonar, mines (pressure sensors), robotics and projectiles. The technology must be industrialized before it can be used in military systems.

N85-105. TITLE: Broadband Display Technology

CATEGORY: Advanced Development

DESCRIPTION: Develop interactive and interpretive display techniques to provide sensor operators with better capability to perform broadband detection, classification, and localization. This task would support the airborne acoustic signal processing system (AQA-7 and UYS-1) Broadband Enhancement Programs as well as the Low Cost Sonobuoy effort.

N85-106. TITLE: Mine Sensors and Signal Processing

CATEGORY: Exploratory Development

DESCRIPTION: The most effective naval mines contain a device capable of detecting the location, course and type of potential underwater or surface target vessels at a distance without generating signals from the mine. The

contractor will define an approach based upon proven technology, conduct an analysis to determine the operational characteristics (range, accuracy, noise immunity, power consumption, etc.) of the device and prepare a development plan describing the cost and schedule for all phases: design, fabrication, test, evaluation, reliability and producibility reviews, production and logistic support.

N85-107. TITLE: Improved Towed-Array Processing

CATEGORY: Exploratory Development

DESCRIPTION: Develop an adaptive processing algorithm to cancel interfering signals arriving at a linear towed array. The main effect of this algorithm would be to remove signals arriving in side lobes from the main bearing response.

N85-108. TITLE: Broadband Tracking Algorithm Development

CATEGORY: Research

DESCRIPTION: Conduct an analysis to propagate in time a four-dimensional probability distribution function in x, y, x (x velocity) and y (y velocity) in a two-dimensional grid by using "bearings only" techniques. Evaluate tracking capability of various current and proposed Broadband Sonobuoy/Processor Systems using this algorithm.

N85-109. TITLE: Cross-Correlation Processor

CATEGORY: Exploratory Development

DESCRIPTION: Develop cross-correlation processor to be embedded in the surface ship towed-array system, #SQR-17V(4). The cross-correlation inputs will be (a) towed-array split-beam pairs; and also (b) towed-array full-beams/sonobuoys/hull-beam data. This processor will be later utilized at sea to demonstrate inter-sensor/inter-platform real-time bearings/multipath processing.

N85-110. TITLE: Minefield Theory Methodology

CATEGORY: Exploratory Development

DESCRIPTION: Development of minefield and mine countermeasure theory and related analytical models which can treat the entire stockpile-to-target sequence and be used to evaluate complex multiport and campaign-level scenarios. Near-term application of this improved methodology will allow more realistic predictions of the effectiveness of various minefield designs; permit more efficient utilization of available mining assets; provide a capability to accurately determine stockpile requirements; and realistically compare the attributes of new mine design concepts.

Specific items of interest are new applications of computer-intensive techniques to serve as tools for minefield planners and hardware designers. Examples are: computer-aided design techniques, artificial intelligence methodology, and statistical methods for validating complex minefield analysis models on the basis of small samples of field measurements.

N85-111. TITLE: Interface Studies

CATEGORY: Research (6.1)

DESCRIPTION: Study and determine the properties of the interface between aluminum and graphite in graphite-aluminum composites. The results of the study should show clearly the effect of different interfaces on the transverse properties of graphite-aluminum composites.

N85-112. TITLE: Doppler Shifted Chaff

CATEGORY: Exploratory Development

DESCRIPTION: Modern efforts to provide a capability for radars to detect and track air targets in the presence of chaff rely on high-velocity resolution, and to a lesser extent, high-range resolution. The requirement to operate in high-target-density situations and to provide automatic handling of the various operations leading to engaging targets has led to radar mechanizations whereby chaff and other clutter signals are removed by fixed and adaptive MTI-computations prior to any tracking operations. The properties of chaff that allow this are that it quickly slows to local air speed.

The contractor shall design and fabricate a low-cost S-band amplifier in an RF repeater configuration with separate isolated receive and transmit antenna elements (vertically polarized) with a programmable frequency offset. Maximum elements (vertically polarized) with a programmable frequency offset. Maximum doppler-shifted radar cross-section is desired, consistent with an ERP of about 1 watt per square meter. Minimum volume is desired in a configuration which can accommodate a battery and parachute. Ultimate use will require launching from a chaff hopper either individually or, preferably, in a two-stage operation.

N85-113. TITLE: Characterization of Damage in Composite Materials

CATEGORY: Exploratory Development

DESCRIPTION: It is not currently possible to nondestructively quantify composite material damage. The purpose of this study would be to investigate techniques which could be developed and then utilized to ascertain the extent of damage sustained by a motor case or interstage structure. This data could then be applied to an accept-reject criteria for damaged structures.

N85-114. TITLE: High-Speed Turbine

CATEGORY: Advanced Development

DESCRIPTION: Design and fabricate a turbine wheel for missile power generation applications, capable of delivering high efficiency (40%) at high speeds (250,000 RPM) operating on inert gas (helium, argon, nitrogen). The size of interest is two inches in diameter or less, with a power output of 3 HP. Emphasis should be on efficiency, light weight and reasonable cost. Designs capable of operating with warm gas (2500°F) are also of interest. Testing with warm gas could be conducted by the Navy activity monitoring the effort.

N85-115. TITLE: Rate-of-Descent/Altitude Transducer

CATEGORY: Management and Support (Test and Evaluation support)

DESCRIPTION: Development of a Rate-of-Descent transducer capable of sensing the rate of descent and altitude within a range of 0-400 feet over a temperature range of -55 C to +65 C. The accuracy shall be held within  $\pm 1.7$  of reading over the entire range.

The development of this transducer would allow it to be used instead of existing techniques to provide an on-board system which can be interrogated at given decision points.

N85-116. TITLE: Passive Variable Resistance Techniques

CATEGORY: Engineering Development

DESCRIPTION: Thermal stability and the absence of large thermal gradients are key design elements in maintaining accuracy through improved stability of critical alignments and also aids in improved performance of the inertial components.

A technique whereby the thermal resistance across a heat flow path can vary as a function of the heat flux present would result in improved thermal stability in critical areas. In particular, the development of a compact passive variable thermal resistance device would represent a unique advance in thermal design.

N85-117. TITLE: Declassification of Magnetic Bubble Memory

CATEGORY: Engineering Development

DESCRIPTION: The objective of the project is to develop a nondestructive and fail-safe method of quickly declassifying Intel bubble memories. The goal is to develop a technique which can be applied to standard electronic modules (SEM) or can be used in a factory environment. The present methods of erasing Intel bubble memories have shortcomings in that they either destroy the device, are cumbersome to apply, are slow or are not verifiable (because they

erase the bubble map and seed bubble as well as the data). The results of this effort could relieve security classification problems that would otherwise exist at shipyards, tenders, trainers, and factories during integration and test, as well as during normal or faulted system alteration.

N85-118. TITLE: Electrical Analysis of VLSI Interconnections

CATEGORY: Engineering Development

DESCRIPTION: Achieving high thruput VLSI/VHSIC benefits at the system level requires increased wiring density at high digital speeds; these result in more complex interconnection configurations.

Analytical techniques exist to predict electrical performance (Z0, time delay, cross talk, etc.) of simple configurations. These techniques require extension and development to be suited to three-dimensional, more complex wiring patterns.

Improved techniques will allow design optimization and development of CAD "wiring rules."

N85-119. TITLE: Evaluation of Undershoot Effects on NMOS Microcircuits

CATEGORY: Advanced Development

DESCRIPTION: The effects of negative voltage pulses (resulting from signal reflections) on the input signal pins of NMOS technology microcircuits are largely unknown. A test and evaluation program which identifies and quantifies immediate and long-term performance and reliability degradation as a function of NMOS device type and/or input structure, negative voltage pulse amplitude and duration, and other electrical and environmental parameters is required in order to properly specify and apply NMOS devices in military electronic systems.

N85-120. TITLE: EPROMS Evaluation

CATEGORY: Advanced Development

DESCRIPTION: There is a need for an evaluation of the applicability of UVEPROMS and EEPROMS for military use. Program retention is of prime importance to military applications. A study should be undertaken that will define the effects of environment on data retention (i.e., what conditions will affect data retention and how much in tactical systems).

N85-121. TITLE: PROM Programming Methodology

CATEGORY: Advanced Development

DESCRIPTION: The method of shorted junction fuse of programming a PROM (i.e., the characteristics of the programming pulse (amplitude, ramp, how many, etc.)) affects the reliability of the blown fused-link or shorted junction

fuse. New technology PROMs such as Titanium-Tungsten of shorted junction have not been studied from the viewpoint of military programmability. This study should determine what factors affect the reliability of the blown or shorted junction and what their values should be in order to guarantee a reliable program bit. This should include determination of the value of burn-in after programming in improving part reliability.

N85-122. TITLE: Alpha Particle Effects

CATEGORY: Advanced Development

DESCRIPTION: The trend in IC technology has been toward decreasing geometry and increasing the number of components compromising a single device. This shrinkage, along with other factors, can lead to alpha particle and secondary cosmic ray-induced soft errors. The purpose of this effort would be to look at and analyze the sensitivity of 64K and 256K DRAM comparing the various types and manufacturers.

N85-123. TITLE: Package Electrostatic Discharge (ESD) Susceptibility

CATEGORY: Advanced Development

DESCRIPTION: ESD has been identified and verified as a costly and all too frequent failure mode for today's and tomorrow's small geometry microcircuits. Current efforts are underway to identify susceptibility by technology (CMOS, T-L, etc.). It is felt that certain package types may be more susceptible during the assembly and testing processes than others. The purpose of this effort would be to conduct a statistically-based study among more popular military packages used by various microcircuit manufacturers.

N85-124. TITLE: Advanced Sensor Development

CATEGORY: Engineering Development

DESCRIPTION: Emerging technology may make it feasible to develop new sensors of specific interest to the U.S. Navy. Technological advances in the areas of Special Potential (SP), microconductivity, piezoelectric magnetometers and high resolution temperature measurement techniques may permit new measurements and increased accuracies.

Specifically, the applications for these sensors would include measurement of surface ice thickness from a submerged submarine. The need exists for a device that can be mounted on FBM and attack class submarines that would accurately measure the thickness of ice in northern patrol areas.

New sensors and improved accuracy of existing developments in the field of ocean temperature measurements and microconductivity would have wide application ranging from more accurate measurement of fluid flow across the launch area of FBM submarines to passive detection of internal waves generated by submarines.



N85-125. TITLE: Very High-Speed Integrated Circuits

CATEGORY: Engineering Development

DESCRIPTION: Research and development work to date in the field of Very High-Speed Integrated Circuits (VHSIC) indicates significant promise for the use of devices in special applications where extreme compactness, minimal power consumption, and high reliability are required.

The expected work would consist of applied studies in the area of VHSIC technology for use in airborne missile systems at S-band and L-band for applications in telemetry and navigational transmitters and translators.

N85-126. TITLE: Improved Temperature Sensing Systems/Instrumentation

CATEGORY: Advanced Development

DESCRIPTION: Fast response rate coupled with high accuracy temperature sensing system is needed in the range of ambient to 1000F temperature environment. Rates associated with missile launcher eject chamber applications encompass temperature changes of hundreds of degrees Fahrenheit in less than 10 milisec.

N85-127. TITLE: Small, Self-Contained Aircraft Fatigue Data Recorder

CATEGORY: Exploratory Development

DESCRIPTION: A requirement exists to develop a small, self-contained and self-powered solid-state recorder to measure and store multiple levels of normal acceleration and/or strain exceedance data. The system size must be minimal for easy installation and removal at a variety of structural locations on Navy aircraft. The recorder must be capable of storing at least one month of data from operational aircraft. Data could be stored as exceedance counts (number of times that normal acceleration or strain exceeds selected levels) or as counts of peak-to-valley cycles (number of times that excursions of normal acceleration or strain occur within selected ranges), but other data formats are not excluded. Features to permit resetting of the exceedance levels or ranges and to exclude small variations of the measured parameters are desirable.

N85-128. TITLE: High-Performance Porous Materials

CATEGORY: Exploratory Development

DESCRIPTION: High-performance porous materials are required for the development of laminar flow technology. Laminar flow offers significant payoff to undersea submersibles by providing drag reduction and reduced radiated noise.

Specifically, it is highly desirable to develop the technology to fabricate contoured exisymmetric shells up to 21 inches in diameter. These shells must be high strength (pressure differential of several hundred psi),

corrosion resistant (sea water environment), have very uniform flow properties and have smooth surfaces and contours.

Technologies that have been considered include powdered metallurgy and electron beam drilling. These techniques may be improved or new technology developed to achieve the desired product.

N85-129. TITLE: Superconductivity Projector

CATEGORY: Exploratory Development

DESCRIPTION: A possible low-frequency underwater acoustic projector would employ one or more superconducting coils used with one or more normally conducting coils. Each of the normally conducting coils is connected to a radiating piston. The driving force is the oscillating magnetic force between pairs of coils. The problem is to design and test coil and piston mounts that maximize the electro-mechanical coupling, minimize thermal losses, minimize eddy current effects and provide an efficient, dynamically-balanced mechanical coupling to the acoustic medium.

N85-130. TITLE: Object Detection in Very Shallow Water

CATEGORY: Exploratory Development

DESCRIPTION: Means are sought of detecting and localizing objects of oil drum size in water depths 10-30 feet where surf conditions and burial of objects by natural means render conventional acoustic methods inadequate. Air, surface or subsurface sensor platforms may be considered.

N85-131. TITLE: Solid-State Electronic Wind Sensor

CATEGORY: Exploratory Development

DESCRIPTION: Development of a solid-state (no moving part) wind measurement and direction sensor would alleviate many of the serious at-sea maintenance problems associated with the existing anemometer. Develop new/adapt existing commercial grade solid-state sensors for operation in a naval environment. The sensor shall be capable of 0-100 knot measurement range with a  $\pm 1.0$  knot accuracy for 0-60 knots and  $\pm 2.5$  knots through 60-100 knots. Directional accuracy is  $\pm 2$  degrees through 0-360 degrees. The sensor shall be designed to pass the following qualification tests:

- Temperature, Low 0°C - MIL-STD-810, Method 502
- Temperature, High 50°C - MIL-STD-810, Method 501, Procedure 1
- Humidity - MIL-STD-810, Method 507, Procedure IV
- Salt Fog - MIL-STD-810, Method 509
- Icing - MIL-E-16400, Paragraph 3.3.5.8
- Shock - MIL-S-901, Grade B, Deck Mounted, Class 1, Lightweight
- Vibration - MIL-STD-167-1, Type 1

- Electronic Equipment - MIL-E-16400, Paragraph 4.8.5
- Electromagnetic Interference - MIL-STD-461 & MIL-STD-462

N85-132. TITLE: Secure Video Doppler

CATEGORY: Engineering Development

DESCRIPTION: Video doppler information is a major requirement to evaluate the performance of most aircraft and ground launch missiles. Presently, this analog signal requires substantial video bandwidth. It is the parameter which is most guarded in missile testing because it provides the ultimate answer to the success of the firing. Under the present internal climate, the aircraft and missile industries will be required to secure their telemetry data.

This study is intended to provide technical information as to the best system approach to the solution of video doppler data with respect to the secure TM requirement. The study will also provide the information to include standard telemetry data which has been encrypted on the same data link. These guidelines will lead to the designation of the design of the equipment necessary to accomplish this task.

N85-133. TITLE: Automatic Computer Image Generation Data Base

CATEGORY: Exploratory Development

DESCRIPTION: Aircraft pilot training in simulators is an established technology that uses computer image generation (CIG) to produce the visual scenes that are displayed in the simulated cockpit. The visual scene data bases are currently modeled by hand; that is, it requires at least one, sometimes two people, a photogrammetrist and a data base modeller, to get from raw terrain or cultural data to a useful, modeled CIG data base. The objective of this task is to combine a number of disciplines to develop approaches, techniques, hardware and software to do automatic CIG data base generation. The primary data source would be photography, probably high altitude and perhaps stereo. Some of the disciplines required would be photogrammetry, computer vision and artificial intelligence. It is envisioned that the "recognition" capabilities of the "machine" would be limited to a repertoire of objects of generic type (it would not have to distinguish between a Chevrolet and a Cadillac). The data base developed would not be an exact replica of the raw photographic data, but a close approximation adequate for training and requiring very much reduced storage capacity.

N85-134. TITLE: Eye Attitude Sensor

CATEGORY: Exploratory Development

DESCRIPTION: A system capable of measuring the pointing direction of a pilot/trainee's eye relative to his helmet is required for an eye coupled display system being developed for a flight training simulator. The required performance is an accuracy of one degree of arc in pitch and azimuth anywhere within a 90 degree cone centered on the forward direction. Since the pilot's head is free to move in any direction, systems which restrict head movement,

either in position or orientation, are not suitable. Another performance requirement is a response time which must be less than 10 milliseconds and preferably less than 5 milliseconds. If the system samples, the sample rate must be at least 120 Hz and preferably 240 Hz, or better. The eye attitude sensor should add no more than 300 grams of head supported weight to the pilot's helmet, though off-helmet components have no restrictions other than noninterference with the pilot's freedom of movement or freedom to observe a wide-angle display projected on a spherical dome of three to six meter radius surrounding the simulator cockpit. A production cost of less than \$100K should be a design goal.

N85-135. TITLE: Computer Simulation of Electronic Countermeasures (ECM) Displays

CATEGORY: Exploratory Development

DESCRIPTION: For the purposes of training Navy radar operators to identify standard classes of electronic countermeasures (ECM), there is a requirement for a substantial video-recording library of realistic "jammed" radar displays. The current method of acquiring the samples has been to film operational radar displays either during naval exercises or using pierside signal-generation equipment. This approach has proven to be expensive and had yielded only a small number of samples of each of the standard ECM types. Furthermore, the video recording quality has been uneven.

As an alternative means of acquiring samples of realistic-looking jammed radar displays, the possibility of generating the displays via computer simulation with graphic output should be considered. This would require modeling the radar display, jamming targets and environmental effects to a level that would produce radar displays that are close to the real thing.

Development of an inexpensive methodology for computer simulation of these ECM displays is required.

N85-136. TITLE: Expert Systems to Automatic Digital Scene Matching Area Correlator (DSMAC) Scene Selection and Scene Enhancement

CATEGORY: Exploratory Development

DESCRIPTION: Use newly developed expert systems and knowledgeable engineering technology to implement automation of DSMAC scene selection now done reliably only by a few trained experts. This technique utilizes knowledgeable engineers who work alongside the current experts for 3-6 months. The knowledgeable engineers extract the facts and decision rules from the experts and codify them into a reasoning structure. By repetitive test and refinement, the computer-based Expert System can replace the expert. The study shall also investigate techniques to enhance the DSMAC reference scene using smart algorithms or Artificial Intelligence approaches for Image Exploitation.

N85-137. TITLE: Optimal Cruise Missile Maneuvers Against Gun Systems

CATEGORY: Exploratory Development

DESCRIPTION: Survivability of cruise missiles against Naval Gun Systems is influenced by several interrelated factors. The purpose of this study will be to evaluate the maximum survivability that is gained from optimizing a cruise missile's end-game maneuvers. A trade-off study should be conducted comparing trajectories with two-dimensional maneuvering at low altitudes and those trajectories with one-dimensional maneuvering at sea-skim altitudes (i.e., those trajectories lying in a ship's radars multipath regime). Maneuvers studied will be constrained to maintain a high probability of the cruise missile hitting the target ship.

N85-138. TITLE: Modeling Advanced Gun System Predictors

CATEGORY: Exploratory Development

DESCRIPTION: Existing computer models listed to conduct survivability studies for cruise missiles against Naval Gun Systems are based on track filtering technology of the 1960s. The latest innovations in track filtering technology were made in the mid 1970s and were refined over the past decade. The objective of this work is to design and code the modern algorithms to provide a computer model which will be relevant for studies of Gun System Predictors that may exist in foreign systems in the early 1990s.

AIR FORCE SMALL BUSINESS INNOVATIVE RESEARCH PROGRAM  
Submitting Proposals on Air Force Topics

Topics #1-3

Special Assistant  
for Program Coordination  
ASD/AE  
Building 57/Bay 1  
Wright-Patterson AFB OH 45433

Topics #4-5

ASD/ENO  
Engineering Operations Office  
Building 14, Room 208  
Wright-Patterson AFB OH 45433

Topic #6

ASD/RWEE  
Building 28, Room 015  
Wright-Patterson AFB OH 45433

Topics #7-9

ASD/TAA  
Building 16, Room 120  
Wright-Patterson AFB OH 45433

Topics #10-17

Directorate of Concepts  
and Innovation  
ASD/XXR  
Building 11A, Room 201  
Wright-Patterson AFB OH 45433

Topic #18

Deputy for Propulsion  
ASD/YZD  
Building 46, Column 1D5  
Wright-Patterson AFB OH 45433

Topics #19-29

Avionics Program Office  
AFWAL/GLXPA  
Building 22, Room S110  
Wright-Patterson AFB OH 45433

Topics #30-40

AFWAL/GLXPF  
Area "B", Building 45, Room 149  
Wright-Patterson AFB OH 45433

Topics #41-60

AFWAL/GLXPM  
Area "B", Building 653, Room 406  
Wright-Patterson AFB OH 45433

Topics #61-70

AFWAL/GLXPP  
Programs Group  
Bldg 18A, Room A-103  
Wright-Patterson AFB OH 45433

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Please note that, because of unique circumstances, proposal deliveries to the Wright-Patterson AFB complex will require additional time (about one day) for processing to the correct office. Accordingly, bidders should plan an additional time allowance for proposal delivery to the correct office as stated in this solicitation. Many FY 84 proposals were not considered for evaluation/award because of late delivery.

Topic #71

AFSTC West Coast Office OL-AB  
PO Box 92960  
Building A2, Room 2205 (S. Wagner)  
Worldway Postal Center  
Los Angeles CA 90009

Topics #72-73

HQ Aerospace Medical Division  
AMD/RDO  
Directorate of Resources and Operations  
Building 150, Room 224  
Brooks AFB TX 78235

Topics #74-128

USAF Ballistic Missile Office (BMO)/PMX  
Building 951, Room 108  
Norton AFB CA 92409

Topics #129-140

WCO/AFSTC  
PO Box 92960, WPC  
Los Angeles CA 90009  
(Mail)  
WCO/AFSTC  
2350 E. El Segundo Blvd  
Building A-2, Room 2219  
El Segundo CA 90245  
(Hand Carry)

Topics #141-144

HQ AFSTC/XNE  
Building 497, Room 122  
Kirtland AFB NM 87117

Topics #145-153

AFWL/PRP  
Building 497, Room 241  
Kirtland AFB NM 87117

Topic #154-159

AFGL/XOP  
Building 1107, Room 200  
Hanscom AFB MA 01731

Topics #160-165

AFRPL/TSPR  
Building 8353, Room 115  
Edwards AFB CA 93523

Topics #166-174

RADC/DORM  
Building 106, Room A112  
(Attn: Mr M. Donovan)  
Griffiss AFB NY 13441

NOTE: FOR REMAINING ADDRESSEES OF TOPICS 175-218, REFER TO PAGE 188

1. TITLE: Electro-Optical Power Supply

DESCRIPTION: The purpose of the power supply is to provide impedance matching, electromagnetic pulse (EMP) protection and a stable and reliable power source.

The power supply is made up of an electroluminescent lamp bonded to a series connected photovoltaic cell to provide five volts whenever the lamp is powered up. The lamp and cells may be made into as many layers as necessary to provide sufficient power to drive the circuit card. A regulator and capacitor may be needed to provide stable power.

EMP protection will be achieved because the lamp is a high impedance device, thus any surge coming through could go to ground.

This technique would provide a low cost power supply that would be compatible with the newer high speed circuits. As a matter of fact, the power supply could be built into the printed circuit card, thus reducing the space required and improving the packaging efficiency.

2. TITLE: Low Temperatures, Low Pressure Water Separator

DESCRIPTION: The purpose of the water separator is to remove subcooled water droplets from the environmental control system (ECS), air distribution system ducting in an aircraft. Present systems cannot operate at temperatures below or near freezing, i.e., 32°F. The airflow is in the +32°F to -10°F temperature range. The water droplets, mostly in the submicron size range, form ice on any surface on which they impinge. If it were possible to remove the ice from the airstream, the performance of the ECS would be significantly enhanced.

The requirement is to remove all ice from the impingement surface and exhaust it overboard. Due to the lack of availability of energy, the use of some means of generating heat is not acceptable. A typical cooling system for a small/medium size aircraft has an airflow of 25 pounds per minute, which is the desired handling capacity of the separator. The size of the separator shall be less than 0.7 cubic feet.

3. TITLE: Electroluminescent (EL) Lamps to Achieve Higher Brightness, Longer Life, and More Uniform Light Output Over Time

DESCRIPTION: Electroluminescent lighting is an important source of illumination for a wide variety of Air Force requirements. It is being used for illumination of instrument panels, for flood lighting in cockpits and cargo areas, for runway lighting, for formation lights on aircraft, etc. Green electroluminescent lighting is a compatible light source for use with night vision goggles (NVGs) and enables pilots and others to look at information displays and not cause interference with goggles.

Improvements in several areas would increase the possible applications for electroluminescent lamps: brighter EL lamps could be used in caution/warning and status indicators which require daylight readability. Presently, dual lighted displays are being used in aircraft that use NVGs, incandescent for daytime readability and EL for night and NVG compatibility. Additional



work needs to be accomplished in EL lamp fabrication techniques to increase their producibility and the development of lamps with flatter life curves (present lamp light emissions decrease with time). Existing lamps have a useful life of approximately 6000 hours at 115VAC 400Hz power.

4. TITLE: Brushless D.C. Motor for Mini-Drone Propulsion

DESCRIPTION: Recent advancements in battery energy density suggest that direct current (DC) brushless electric motors offer the potential of providing an ultra-reliable and long-term storable alternative to gasoline engines as propulsion systems for small drone aircraft. Suitable batteries are expected to be available in late 1984. Present system estimates, that indicate a 3 to 4 hour mission duration, will be possible if the propulsion (electric motor) can be significantly improved.

The solid state, logic driven rotary device, called a "brushless DC motor", is the first motor improvement in years that exhibits the light weight and high power density necessary for efficient aircraft propulsion application. To date, these motors have not been produced in larger sizes (such as 10-20 horsepower) that have application for mini-drone propulsion use.

A motor design development effort is proposed that has two significant objectives. One, an instantaneous automatic motor logic control development that will respond to shaft loading and will hold maximum efficiency motor operation without any external input. Automatic servo control circuitry is not new but integration with brushless DC motor control logic is new and can be an innovative research effort. A drone that can climb, cruise, or dive and a motor that will respond with optimum power and proper shaft RPM will be new (i.e., no throttle or software stored throttle information). The other objectives are minimum size and weight in larger horsepower sizes. This objective has not been accomplished to date but is considered within the state of the art.

The objective of this effort is to develop and demonstrate a flyable motor and motor control system. The goals are a 10 horsepower system not to exceed 25 pounds total weight and a 20 horsepower system not to exceed 40 pounds. These systems must be able to replace existing gasoline engines for flight demonstration purposes.

5. TITLE: Feasibility of Automatic Direction Finding for Spread Spectrum Communications

DESCRIPTION: Automatic direction finding (ADF) is an adjunct to ultra-high frequency (UHF) radio communications. It has long been used for search and rescue of downed pilots and tanker rendezvous for air refueling missions. UHF/ADF equipment, such as the OA-8697/ARD, can process detected amplitude modulated audio (voice or tone) signals to provide relative bearing to the signal source. It accomplishes that by rotation of an antenna cardioid pattern that translates the spatial angle of an incident radio frequency signal into a phase difference between the antenna modulated output and a reference signal synchronous with antenna rotation.

Some radio systems now in development utilize spread spectrum modulated RF signals to provide reliable radio communication in the presence of electronic jamming. Present UHF/ADF equipment is not compatible with spread spectrum systems because the desired signal is not sorted from undesired signals until after correlation detection. Consequently, present UHF/ADF sets are not being considered for use with these new communication systems.

The objective of this effort is to perform a general feasibility study and analysis of the application of automatic direction finding systems to spread spectrum radio communication. Capabilities of ADF systems as a navigation aid must be determined while operating in a tactical communication, jamming environment.

6. TITLE: Test Equipment for Avionics Beyond 18 GHz

DESCRIPTION: The frequency range of developing and about to be fielded RF avionics equipment is expanding above 18 GHz. That avionics equipment will be maintained and calibrated (supported) under the same maintenance concepts and by the same people that support today's avionics. However, a quick review of test equipment catalogs reveals that there is not much test equipment for maintaining and calibrating avionics and test equipment that operate beyond 18 GHz. Research needs to be performed to determine:

a. What test equipment is presently available to support RV avionics operating above 18 GHz.

b. What test equipment, scheduled for release by January 1987, will be available to support avionics operating above 18 GHz.

In the past, it was correct to assume that a majority of the test equipment and test techniques or methods were available to support avionics systems that were being developed. Test equipment efforts were usually concerned with selecting the proper test equipment and integrating it into an efficient support system. The recent rapid exploitation of the RF spectrum beyond 18 GHz may mean that the assumption is no longer correct. If the research reveals that the development of test equipment rugged enough for military use has not kept pace with avionics development, then the research should also address:

a. What test equipment development efforts should be the subject of 6.3 developments in FY 86, 88, and 90?

b. What test equipment development efforts should be the subject of 6.4 developments in FY 86, 88, and 90?

c. What peculiar test techniques, methods, and facilities are required to support RF avionics and test equipment that operate beyond 18 GHz?

7. TITLE: Continuous Production of Carbon Composites

DESCRIPTION: Carbon composites show great promise of producing next generation, high performance aircraft. Composites are very light, highly durable, and strong. The present process of producing composite material is a slow, manual

process. A need exists to study the feasibility of devising a continuous production process for carbon composites. The research should consider all processes required to manufacture carbon composites from carbon fabric. Repairability features should also be addressed in terms of how the process could be adapted to repair composite material.

8. TITLE: Development of Innovative Advanced Performance Titanium Casting Alloys

DESCRIPTION: During the past decade, the use of titanium casting has advanced to the point where castings are now being used routinely in advanced airframe, engine, and missile applications. However, only conventional cast and wrought (ingot metallurgy) alloys are being used. It appears that a major unexplored area exists for development of alloys specifically for castings, in a similar manner to the alloys developed for the superalloy system about 12 years ago. Research should be conducted to evaluate the feasibility of alloying additions to titanium which would allow improved castability (reduced reaction with casting ceramics) while exhibiting mechanical properties at least equal to those now routinely attainable in conventional alloys. The research should include mechanical property evaluations, including those necessary to ensure structural integrity.

9. TITLE: Low Density Titanium Alloy Development

DESCRIPTION: The use of titanium alloys in advanced structural concepts is likely to decrease because the density of conventional titanium alloys is significantly higher than advanced composites and powder aluminum alloys. Research should be conducted to investigate the feasibility of developing a new class of titanium alloys with low density, which could approach that of conventional aluminum. Effects of production methods, fabrication techniques, and alloying additions should be included. Use of this new material would be contingent on acceptable mechanical properties, particularly fracture-related behavior such as fracture toughness and fatigue crack growth rate.

10. TITLE: Aeronautical System/Subsystem Innovative Concepts

DESCRIPTION: This category of innovative concepts is intended to cover all facets of aeronautical system/subsystem research, development, and procurement. It is also intended to provide latitude to the innovator to include areas not specifically addressed by other specific aeronautical topics. This general area covers the full spectrum of Air Force aeronautical missions (i.e., tactical, airlift, mobility, strategic, transatmospherics, etc), and functions (i.e., materials, propulsion, flight controls, etc). Proposals as diverse as new weapon system concepts and improved training techniques can be submitted. Some other areas of interest are high energy fuels, maintenance free systems, facility threat, countermeasures, applications of artificial intelligence, etc. This topic is structured to provide a maximum of innovative flexibility to prospective participants.

11. TITLE: Cryo-magnetic Materials Research Program

DESCRIPTION: This topic is intended to establish a formal research effort in the general area of cryo-magnetic effects on altering and enhancing fundamental

properties of materials for any type application. The feasibility research will include a survey of national/international activities in this area, and the identification of potential materials and properties of materials to be investigated. The research should include devices which provide temperatures to a few degrees above absolute zero to temperatures achievable by using the Peltier effect. Magnetic fields generated should be high density static as well as high density rotating fields. The products of this research effort would be recommendations for the requirements to establish research programs and requirements to implement such programs.

12. TITLE: Feasibility Study on Frequency Domain Target Signatures

DESCRIPTION: Current electro-optical techniques used to provide target recognition/identification require high resolution resulting in limited range or narrow field of view and are limited by weather, night, and foliage obscurity. Target recognition/identification techniques which utilize target data collected from electromagnetic sources covering the spectrum of power through microwave frequencies may provide increased capability. The measured sources could be cooperative, non-cooperative, unintentional, or natural in origin. These frequency domain characterizations would be examined to determine the increased detectability of targets and their identification. The research would initially examine the scope of target related electromagnetic characteristics which, when collated, would yield target signatures, and would include factors such as dipole, tuned cavity effects, target generated energy due to operation, etc. The research would determine the feasibility of establishing a research program in the frequency domain area and its potential benefits.

13. TITLE: Transatmospheric Mission Sensor Technology

DESCRIPTION: This effort is to examine the unique and innovative approaches to vehicle sensor technology during the transatmospheric phase (100,000-500,000 ft) of its mission. The use of extendable/retractable sensor arrays for both electromagnetic as well as electro-optical sensors which permit greater performance in resolution, range, and power requirements than vehicle enclosed systems is an area of interest. Additionally, multimode arrays reconfigurable in the transatmospheric environment are another area of interest. A research proposal should result in a programmatic approach to systematically examining the entire area of sensors, with specific areas of promising potential for vehicles operating at altitudes in the range of 100,000-500,000 ft.

14. TITLE: Expert System Use of the Ada Interface to Other Computer Languages

DESCRIPTION: Expert System Software for airborne use will be installed in embedded computers working in a multitasking environment. Ada is the standard language for embedded computers, but, by itself, may not be the most practicable or acceptable language for applying expert system technology. It may be necessary to use other languages such as LISP, PROLOG, Smalltalk, or Fourth. Because of this Ada interface to other languages feature, it is possible to adhere to the Ada standard and yet make use of these other specialized languages.

The interface to other languages specifies the calling conventions and informs the compiler that an object module will be supplied for the

corresponding subprogram. This interface capability may not be provided by all Ada compilers.

There is a need for an expository report on this Ada language feature as it relates to LISP, PROLOG, Smalltalk, and Fourth. This report would also include a qualitative evaluation of the utility and limitations of the interface to other languages feature. Optionally, the report may include a proposed method for the quantitative demonstration of the utility of the interface to other languages feature.

15. TITLE: Investigation of Concepts to Add Computer Aided Decision Devices (Artificial Intelligence) to the Tracking and Targeting Tasks of the Airborne Fire Control and Missile Systems

DESCRIPTION: The objective of this topic is to develop a computer aided decision device or software that will increase the kill probability of a weapon system. Currently, the only data that are transferred from the fire control system to the missile is in terms of "finite instruction." It is believed that increased kill probability could be achieved by using the "if - then" instruction of the artificial intelligence type software program. Research is needed to combine these principles to develop a better total weapon system.

16. TITLE: Decontamination by Activated Oxygen

DESCRIPTION: Activated oxygen has the potential to break down certain compounds, namely organophosphorous compounds - chemical warfare agents. The feasibility of creating activated oxygen has been studied, but not the feasibility of generating large amounts for destruction of a large mass of compounds. The cost and complexity of materials and equipment necessary for generation of the gas must be investigated. Since activated oxygen is quite reactive, the effect on materials to be decontaminated is an important consideration. Activated oxygen must be compatible with most airbase materials, particularly aircraft and ground crew ensembles. The need for a quick decontamination method is driving this type of technology, therefore the time to completion of the reaction is a key question that needs to be answered.

17. TITLE: Development of an Interactive Computer-Aided Design for Analysis of Control Systems

DESCRIPTION: Many advanced aircraft designs with relaxed stability require methodology to synthesize and analyze control systems rapidly. Many software packages exist which can aid in performing control system analysis but unfortunately they are not set up to operate interactively. What is needed is an innovative approach which allows interactive computer-aided design and analysis of controllers and estimators for multi-variable systems. Both classical and modern control design techniques should be used, allowing for transformation between state space and frequency domain. Provisions should be included to accommodate the dimensional stability derivatives as inputs allowing for a transfer function and/or state space description. Also, the means to transform from physical variable state space to various canonical representations is essential. As a minimum, the controller and observer form are necessary to conduct in-house analyses. Pole placement techniques should be part of this

research. The software should also be able to utilize linear quadratic gaussian algorithms.

Also, a trajectory optimal control program for non-linear air vehicle equations of motion is required for both aerodynamic and thrust controls. The input format should allow a description which includes the vehicle aerodynamics as a function of mach and angle of attack, the weights, and propulsion data. The optimizing performance criteria should include parameters such as velocity, range and, in some cases, vehicle characteristics (e.g., thrust/weight, wing loading). Allowances should be made for equality constraints such as angle of attack and load factor. This methodology should also be available on a digital computer for interactive analysis. This interactive program must be compatible with the VAX/780 computer system.

18. TITLE: Tech Mod for Small Businesses Supplying Products to the Propulsion Sector

DESCRIPTION: The Tech Mod Program addresses the development, integration, and implementation of new manufacturing technology which can be applied to the propulsion sector. Small businesses which are currently either supplying machine tools or processing equipment to the propulsion sector or companies which are supplying parts and hardware to the propulsion sector are encouraged to submit proposals. The proposals may either relate to improvements which are or will be offered to the propulsion sector or improvements which are or will be implemented within the company offering the proposal and which will significantly reduce the cost of propulsion systems to the United States government. The types of work included in Tech Mod are study, development, and implementation efforts relating to:

- a. enabling technology;
- b. design of material handling, storage, and movement systems;
- c. design of special tools, test equipment, and inspection equipment;
- d. design and integration of factory layout and workcells;
- e. qualification of new processes, cells, and work centers;
- f. qualification of hardware produced by new processes;
- g. integration of new technology into the production systems; and
- h. management information systems (internal to the company only).

19. TITLE: Gallium Arsenide (GaAs) Device

DESCRIPTION: Research is needed to understand better the physics of GaAs device and circuit operation. These devices and circuits are needed for avionics, missile and space applications. Such devices provide ultra high speed digital data rates, and recently clock rates of 10.0 gigahertz at 77°K were observed. Higher speed circuits allow fabrication of radar systems with improved performance characteristics. Consequently, DOD and especially the Air Force have programs to develop GaAs technology. The purpose of this research is to supplement and enhance the development of GaAs technology. Of prime interest is work on Modulation Doped FET, since this represents a new and extremely promising technology. Other areas of interest are insulated-gate GaAs field effect transistor technology, bipolar heterojunction transistor technology, and MESFET technology. Theoretical, analytical or device and circuit fabrication efforts

are of interest to develop further the above indicated technologies. Theoretical research may include two-dimensional device modeling, evaluation of ballistic effects, velocity overshoot effects, gunn domain formation, and circuit simulation. Analytical work may include materials evaluation by Auger spectroscopy, Rutherford backscattering, etc. Finally, transistors and circuits could be designed, fabricated, and tested. The above description maps out a wide area of interest and the anticipated program would attack a small segment of this above described area. Proposals addressing individual areas will be considered.

20. TITLE: Artificial Intelligence (AI) Development for Pilot Aid Applications

DESCRIPTION: Over the past decade avionics systems have evolved dramatically from the bare essentials of radio and radar, which required minimal crew workload to maintain and operate, to the complex systems of today, which greatly enhance the effectiveness of the aircraft. However, unless something is done to assist the pilot in the operation and supervision of these complex systems, the airplanes of the near future will fall short of achieving their full potential effectiveness. For that reason, an extensive program in the field of artificial intelligence is planned with which to make complex systems smarter, and thus easier for the pilot to interact. All aspects of artificial intelligence will eventually be addressed to seek potential solutions for the avionics complexity problem under this program; however, present areas of interest are focused on the real time environment of the cockpit where new data are constantly acquired and acted upon to insure that mission goals are achieved.

In view of the above, research is needed in the following areas:

(1) Development of "real time" inference systems which can deal with multiple opponent aircraft and predict/estimate the intentions and capabilities of each opponent as well as the collective expected result of their observed actions. Develop "real time" adaptive learning techniques which could automatically update established knowledge bases in the event that expected behavior-capability results deviated from actual behavior-capability results.

(2) Develop "real time" artificial intelligence techniques and algorithms to recognize what knowledge is relevant to the current combat situation. Develop "real time" artificial intelligence techniques that can (1) use default assumptions, (2) reason given incomplete information, and (3) tolerate inconsistent data.

(3) Develop "real time" artificial intelligence knowledge-based signal interpretation systems that can integrate a large amount of data from sensors and can translate those data into knowledge for other system components to use.

(4) Determine the attributes and tradeoffs of LISP versus Prolog as an artificial intelligence language for "real time" military environment applications.

21. TITLE: Compound Semiconductor Research

DESCRIPTION: Thin layers of semiconducting material with very sharp interfaces

have been shown to have a number of properties that are very interesting to the Air Force. Specific device concepts employing these structures are under development, and basic research to support those developments is underway. Primary interest at this time is in the GaAs/AlGaAs system, but other materials will become of interest as they show significant advantages. At the present time, molecular beam epitaxy (MBE) and metal organic chemical vapor deposition (MOCVD) are the primary methods used to grow the thin structures, and there is interest in programs to improve these two techniques or in other techniques that might be better. New physical principles govern the performance of the new class of devices that is evolving and new measurement techniques or variations of established techniques are needed to understand the materials properties that control that performance. Research to show the connection between the material characteristics and device performance is also of interest. Examples of research that would be of interest are: (1) development of experimental techniques to measure interface sharpness between layers of GaAs and AlGaAs to within a half of a lattice constant; (2) development of ways of determining carrier concentration profiles within 100 Å of an interface; (3) development of measurement techniques that would give impurity and defect profiles close to interfaces for both residual and doping concentrations; and (4) research of unique characteristics that would have a significant impact on present or new device concepts. Theoretical research to develop models of the materials properties of thin structures and devices fabricated from those structures is also of interest.

22. TITLE: Communications Jamming Threat Simulation

DESCRIPTION: The primary objective of this program is to define requirements and develop hardware/software design specifications for hardware simulation of the tactical communications jamming threat projected for the 1990's.

The desired simulation capability will be used to evaluate the operational performance of USAF advanced tactical communication system developments. The technical effort should include: (1) identification and detailed description of the projected tactical communications jammers; (2) system level design of the simulation for the jamming threat projected against a selected USAF tactical communications system; (4) if feasible within available resources, implementation of the designs for one or more of the jammers considered under (3). This implementation will be accomplished using Radio Frequency (RF) signal generation hardware currently resident within the sponsoring organization; and (5) validation of the selected jamming signal generation implementation via a hardware Communications Electronic Counter Counter Measures (ECCM) susceptibility demonstration. Innovative, low-cost approaches, taking maximum advantage of off-the-shelf hardware/software are preferred.

Interested parties may obtain a list of the RF generation hardware, referenced in task (4), by contacting the sponsoring organization.

23. TITLE: Computer Operating System Instruction Set Primitives for Ada

DESCRIPTION: The increasing use of real-time multi-tasking software operating systems for avionics computer applications has resulted in the situation where



the operating system overhead consumes a significant portion of system throughput. Much of this overhead results from the fact that an application software call on the operating system normally results in a nested set of context switches through a series of software macro-instruction procedures and/or subroutines. In theory, operating system overhead could be decreased by conversion of all operating system primitive procedures into actual processor instructions by micro-code techniques. Some examples of this conversion would be unitary instructions for handling data structures such as queues, linked-lists, and binary threaded trees. Other examples might include unitary instructions for system resource allocation such as "Get-Memory-Block" or "Get-Input/Output-Channel". In practice, such structuring of the operating system could be incompatible with the use of higher order languages such as Ada. This work would determine what "operating-system-instructions" would be compatible with an Ada programming environment and evaluate the feasibility of implementation.

24. TITLE: Built-In-Avionics Software Test Device

DESCRIPTION: Aircraft flight safety and mission effectiveness is increasingly dependent on computer-based avionics systems. As a result, there is increasing use of real-time fault-tolerant multi-tasking multi-processor systems where faulted processor nodes are placed off-line. Fault detection and real-time confidence testing are the keys to this type of approach. Current approaches to fault detection and confidence testing are based on built-in hardware test logic, the use of watchdog timers on software processes, and on the execution of diagnostic software as a processor background task. Built-in hardware tests do not test "system-health". Watchdog timers and diagnostic software consume processor resource capabilities. It is theoretically possible to develop a device that would reside on a processor system bus and that would perform fault-detection/isolation and confidence testing by passively monitoring system bus communications with signature analysis techniques. This work would determine the parameters of such a device and evaluate the feasibility of developing this device.

25. TITLE: Characterization of GaAs IMPATT Diodes for Active Aperture Applications

DESCRIPTION: The objective of this program is to determine the applicability of gallium arsenide (GaAs) impact ionization avalanche transit time (IMPATT) diodes to satellite active aperture communications systems. Through analysis, the research shall investigate various types of spatially combined IMPATT amplifier configurations (e.g. binary corporate, M-ARY corporate, paralleled) and determine the power level, gain, amplitude and phase tracking, efficiency, and bandwidth requirements for the IMPATT diodes. The research should then experimentally characterize and measure the GaAs IMPATTs to determine if these devices can meet the active aperture systems requirements. Spaceborne environmental constraints such as temperature, 10 year mission life, etc., shall be considered in this effort. The analysis and experimental measurements for this program shall be conducted based upon the transmit active aperture system requirements model presented below. The active aperture operating frequency range is 20.2 to 21.2 GHz; the minimum EIRP is 50dBW (beam steered) and 45dBW (EC beam switched); the half power beamwidth is (1.2 to 1.5 degrees); the polarization is LHCP; the axial ratio overscan volume is 3dB; the cross polarization relative

to principal polarization is -20dB; the sidelobes within plus and minus 3 degrees of equatorial plane and over subtended earth angles are -20dB relative to peak; the antenna input power is +10 dBm at 1dB compression; the beam reposition/settling time is 1 microsecond maximum; the amplifier temperature range is -15°C to +55°C; the channel phase response (deviation from linear phase) is +10° over total band and -5° over any 100 MHz; the third-order intermodulation products for FDMA operation are -10 dBc at rated power, -20 dBc at 13dB backoff and -20Bc at 6dB backoff; the DC input power including DC power supply, beam beam steering computer, etc. shall be 300W maximum; and the scan volume shall be earth coverage.

26. TITLE: Tailored Expert System Generator

DESCRIPTION: It is theoretically possible to design an expert system which would then be capable of designing an expert system. This would greatly reduce lead time in introducing artificial intelligence used as an electronic combat aid to pilots in the tactical aircraft environment. Numerous systems, such as electronic countermeasures expert systems, speech control of avionics, reconnaissance systems, and target recognizers would benefit from reduced development time. The generic expert system could develop criteria and logic to define the expert system needed on a specific application. Given the system requirements, the generic generator would develop and organize the logic needed to work in a particular application, much as a computer-aided design enables engineers to test many designs prior to prototyping. This system, however, would contain the necessary prompts that would direct designer efforts such that, when completed, the output would be an expert system tailored to a specific application. This work would determine the feasibility of such a device.

27. TITLE: Dynamic Range Limitations of Acousto-Optic Spectrum Analyzers

DESCRIPTION: Acousto-optic spectrum analyzers are very attractive for application in electronic warfare RF receiver systems because of their potential small size, low cost, and high reliability. However, to be utilized they must meet stringent requirements for two-tone dynamic range. This refers to the ability of the system to detect a small signal in the presence of a large one. This is in part limited by the presence of spurious signals associated with optical crosstalk. Examples of factors contributing to optical crosstalk are scattering, aberrations, sidelobes, and spontaneous emission in the laser source. The purpose of this proposed effort is to assess the system performance limits imposed by the above factors and to suggest approaches for minimizing their effects. Theoretical models are to be developed that relate optical quality of components of miniature acousto-optic spectrum analyzers to system performance. Some experimentation may be appropriate to guide the theoretical analysis and confirm the theoretical model. It is expected that the theoretical findings will suggest approaches for the development of acousto-optic spectrum analyzers with significantly improved dynamic range.

28. TITLE: Fluorescent Flashlamp Envelopes

DESCRIPTION: Nd:YAG is extensively used in military laser applications but improvements in efficiency of operation are needed. Nd:YAG rods are typically pumped optically with xenon-filled quartz envelope flashlamps. But the emission

spectrum of xenon is not a good match with the Nd:YAG absorption bands resulting in poor energy transfer. Some attempts have been made to use fluorescence converters (materials which absorb flashlamp radiation and re-emit at wavelengths absorbed by Nd:YAG) to improve Nd:YAG lasing efficiency with less than impressive results. One fluorescence converter geometry that deserves further consideration is incorporation of a fluorescence converter (such as  $\text{Ti}^{3+}:\text{Al}_2\text{O}_3$ ) into the flashlamp envelope. Optimization of spectral output for efficient Nd:YAG pumping without a reduction in flashlamp lifetime is desired. In addition, a means by which the envelope fluorescence can be efficiently transmitted out of the envelope and into the laser material is needed. Efficient extraction of light originating in the fluorescent converter is difficult since emission occurs in all directions, many of which will trap the radiation due to total internal reflection (TIR). New concepts for using fluorescent converters in flashlamp envelopes with increased optical pumping efficiency while minimizing TIR are needed.

29. TITLE: Frequency Doubling Tunable Laser Output Technology

DESCRIPTION: Solid state laser materials such as alexandrite and titanium doped sapphire have recently been shown to have continuously tunable output in the red to near-infrared region. Frequency doubling the laser output of these materials would extend the tuning range to the ultraviolet-green range and increase the versatility of these laser materials. However, frequency doubling technology currently involves orienting a doubling crystal for efficient conversion of a discrete and constant wavelength input. In the case of a tunable laser where rapid wavelength changes may be desired, the doubling crystal orientation must track the incoming fundamental wavelength. Research is needed to identify appropriate approaches and techniques for automated operation of a wavelength-following doubler. A wavelength switching response of less than 100 microseconds is desired with greater than 30% conversion efficiency over at least a 100 nm spectral range.

30. TITLE: Stability and Control Research for Supermaneuverability

DESCRIPTION: Most current high-performance combat aircraft are unable to operate effectively near the extremes of the flight envelope. A comprehensive program aimed at removing these deficiencies will significantly enhance the combat capabilities of advanced fighters.

Initially it would be useful to extend the simple analytical aerodynamic tools used at lower angles of attack to the highly nonlinear range, resulting in methods such as nonlinear panel methods, nonlinear lifting line, slender body with vortex interaction, and interactive boundary layer methods. Some such methods already exist but are in need of rigorous correlation with experiment. Also, the effects of aerodynamic lags throughout the flight envelope need to be better determined. Such efforts would lead to rational design methods for a controllable supermaneuverable aircraft.

31. TITLE: Use of Holographic Optics to Demonstrate the Feasibility of Aircraft Head Up Color Displays

DESCRIPTION: The major obstacle to the development of aircraft head up color displays has been the need for very high cathode ray tube brightness necessary

to compensate for conventional optic beamsplitter inefficiencies. With the use of holographic combiners with higher efficiencies this obstacle is fast diminishing. The purpose of this effort will be (1) to use computer techniques to evaluate phosphor/hologram design combinations for application to head up color displays, and (2) to build a head up two color display demonstrator and (3) to propose a design for a head up full color display for future development.

32. TITLE: Application of Artificial Intelligence (AI)

DESCRIPTION: Reconfiguration shows great promise of being able to significantly increase the damage/fault tolerance of flight control (FC) systems. This is done by utilizing other FC surfaces to reconstruct the forces and moments after a surface failure. There are a number of techniques or strategies for doing this.

The role of identification is of fundamental importance in flight control system reconfiguration. A control law is based upon a model of the aircraft, and if the aircraft deviates from the model due to failure beyond specified limits, the control law is no longer valid. By measuring the failure effects, the identification scheme attempts to estimate the new parameter values, and the new model is then used to define a new control law. However, this "adaptive" technique has a fundamental problem - false identification. Identification techniques have varying degrees of sensitivity to noise, disturbance, and other inputs. It is sensible to minimize the use of identification in areas where false identification has serious implications. The purpose of this project is to develop a concept for robust design of a reconfiguration strategy using AI. The ability of the AI to accurately model the new aircraft characteristics in the presence of noise disturbances, initial conditions, and other inputs would be evaluated. The role of AI in reconstructing lost forces and moments would be investigated.

33. TITLE: Non-invasive Electromagnetic Field Sensor

DESCRIPTION: Certain materials change their physical properties in the presence of electromagnetic fields. If the material maintains this change when removed from the electromagnetic field, it may be possible to develop a non-invasive field sensor.

For example, anisotropic crystals have been used to split laser beams, in chop laser pulsed and as electrical switches. Placing these crystals in an electric field results in a change in their conductivity tensor; however, removal from the electric field results in the immediate return to ground state. A crystal with a longer relaxation time could be used as a sensor to provide information on the characteristics of the impressed electric field.

Research should be conducted to determine if such materials exist or can be developed.

A sensor utilizing this material would provide a non-invasive electromagnetic field measurement and would have application in the NEMP and lightning research areas.

34. TITLE: Protective Field Feasibility Study

DESCRIPTION: It is estimated that in future battle scenarios, our aircraft will be flying against heavy artillery fire, including surface-to-air, and other anti-aircraft ordnance. Current protection techniques used to reduce the aircraft's vulnerability to such threats include the application of various types of foam, armor, and self-sealing materials. These techniques reduce the damage incurred by the aircraft through the alleviation of the damage mechanism or the damage potential of the fragment or projectile after it enters the aircraft's skin.

It is conceivable that an even greater level of protection may be achieved if a protective field enveloped the aircraft. This protective field would either defeat or deflect the incoming threat and prevent it from entering the aircraft. This type of system would not only have the advantage of being a single system to maintain, as opposed to the various independent techniques currently used, but would also possess a multiple shot capability.

The feasibility of this concept needs to be studied. Energy and hardware requirements need to be determined, along with the evaluation of this concept's potential (i.e. atmospheric, space, or chemical-biological and applications), to firmly establish whether the objectives are attainable or if additional work is justifiable. It is believed that initially only a limited number of threats may be affected by this concept. But with additional research and development efforts, future advances would be made. Factors may be discovered prohibiting the concept's use on-board an aircraft (i.e. avionics equipment interference), but allowing its application on land or sea vehicles and structures. The potential uses for this passive defense concept are unlimited.

35. TITLE: Spacecraft Heat Rejection Methods

DESCRIPTION: Heat dissipated from electronic boxes and other equipment on orbiting satellites must ultimately be rejected by thermal radiation to space. Coated aluminum panels are often used for this type of radiator. Heat pipes or circulating fluid loops may be included to help distribute the thermal energy in the radiator panel. This provides adequate heat rejection for present day satellites. However, the much higher heat loads expected on future satellites will cause the radiator panels to become a large part of the total satellite mass, and their size will effect spacecraft stability and configuration. A better method of heat rejection is needed.

Research and development is needed to explore innovative design approaches for spacecraft heat rejection subsystems. Heat must be transferred from equipment at approximately room temperature and ultimately rejected from the satellite. Weight, size, and power consumption all need to be considered as well as maintenance of high cleanliness conditions for sensitive instruments. Total heat loads may range from five kilowatts to 100 kilowatts, and the system must operate for five to ten years in space. Phase I analysis should be adequate to determine the feasibility of any new technical approach and should establish the type of development which might be needed for eventual spacecraft implementation of the concept.

36. TITLE: Innovative Tactics for Air Combat Simulation

DESCRIPTION: Multiple vehicle air combat analysis is currently being used to develop combat sensitivities on a digital computer. The results from such simulations are used as an important factor affecting decisions which impact current and future systems characteristics. The heart of combat simulation models are the tactics used which, in turn, drives the results and sensitivities. Current models tend to rely on tactics selected by a decision tree or logic based on relative positions of the various force elements. This effort is to investigate the potential of applying innovative techniques such as learning theory and artificial intelligence to the generation of tactics.

The initial need in this area is to determine what methods are available and the suitability of different approaches. Desired results from this work would be a tactics generation computer model which can be applied to existing air combat simulation programs. It is desired that as part of this effort the model be programmed, tested, and its suitability and feasibility assessed.

37. TITLE: Improve the Aerodynamic Heating and General Boundary Layer Computations of the Parabolized Navier-Stokes (PNS) Code

DESCRIPTION: Three-dimensional boundary layers are evaluated by the PNS code from the fundamental computations. Extracting final data on skin friction and heat transfer as well as accurately evaluating the boundary layer parameters requires a fundamental understanding of advanced viscous flow theory as well as a working knowledge of numerical flow field codes. The current code has rudimentary concepts imbedded in it which require engineering attention and significant updating. This job is to re-work the application of advanced boundary layer theory to the PNS computational output and upgrade the quality of the resultant engineering information.

38. TITLE: Particle Sizing Detection System

DESCRIPTION: Currently, the laser velocimeter (LV)/anemometer technique for flow velocity measurement requires that light be reflected from so called "scattering centers". It is this light that is processed through an optical/electronic detection system to obtain velocity. In most practical cases (actual wind tunnels and flow channels), the natural distribution of seed material is usually not known nor of correct size and does not exist in sufficient quantity. Since natural seed is not useable, seed material is introduced into the flow by a variety of devices, generically referred to as seeders. The size distribution of this seed material must be accurately known so as to project a confidence level that the seed is following the fluid dynamic features of the flow in question. The size region of interest for most LV work is in the range of 0.3 to 3.0  $\mu$ m. Current particle sizers and counters do not allow an in-situ measurement or a measurement during facility operation. What is needed is a system/technique which will provide for, at minimum, particle sizing and count in the environment in question, preferable with the fluid dynamic facility in operation.

39. TITLE: Passive Vulnerability Reduction to Hostile Threats

DESCRIPTION: Fuel fires and explosions from hits to the aircraft fuel system by incendiary and high energy ballistic projectiles and warhead fragments have been the greatest single cause of aircraft loss in past air wars. Many approaches reducing the vulnerability of fuel systems have been proposed but result in penalties to aircraft performance operating costs because of excessive weight, volume, or maintenance characteristics.

Innovative concepts or techniques are sought which could prove effective in reducing the combat fuel fire and explosion threat in fuel tank void spaces or dry bays adjacent to tanks without the performance or cost penalties of current state of the art.

40. TITLE: Trans-Laminar Reinforcement of Organic Matrix Composite

DESCRIPTION: There are a variety of design situations where it would be very advantageous to provide reinforcement normal to the plane of composite plates. Without such reinforcement, composites are very weak in that direction, limiting some designs to low stress levels which could be increased if reinforcements were provided. The most widely used method of providing this reinforcement today is by stitching the uncured laminate with either graphite or Kevlar "thread," but there are a number of drawbacks to this technique, since it requires the use of a relatively large needle, causing damage to the laminate. Stitching is also rather costly if large areas are to be reinforced.

It is desired to investigate innovative techniques (other than stitching) for the trans-laminar reinforcement of organic matrix composites. One approach might be to insert short boron fibers into the uncured laminate using a roller which would insert the fibers into the laminate as it was rolled along the surface. Other techniques are encouraged. A feasibility demonstration should be performed on the method of inserting the reinforcement and a modest test program performed to demonstrate the increase in laminate properties resulting from the reinforcement.

41. TITLE: Improved Nondestructive Evaluation

DESCRIPTION: Nondestructive evaluation plays a major role in the production, operational safety, and maintenance of Air Force systems. Current emphasis has largely been on the inspection of airframe and engine components, sub-assemblies, and entire systems during manufacture and throughout their service lives as a major element of maintenance and repair procedures. The tremendous variations encountered in the articles to be inspected, in matters such as geometry, material composition, service conditions, and defect detection requirements, has led to the study of many physical, chemical, and mechanical phenomena which can be used as inspection techniques. Approaches are needed for improved NDE techniques for the detection and characterization of flaws in airframe and engine materials including metals, composites, and ceramics, in electronic device materials and components, and also for the realtime monitoring and control of manufacturing processes. In particular, research is needed on electromagnetic, ultrasonic, radiographic, and new and improved methods for the detection of bulk and surface defects in metals and composites field level examination of surfaces prior to adhesive bonding, as well as determination

of resin and moisture content in advanced composites, imperfections in material coating, and corrosion. Of particular interest are those efforts which give an improvement in the reliability of the inspection process which allow the quantitative characterization of the flaws.

42. TITLE: Improved Aluminum, Titanium, and Magnesium Alloys

DESCRIPTION: New approaches leading to improved rapid solidification technology (RST) for aluminum, titanium, and magnesium alloys are needed.

Current Air Force interest in aluminum alloys centers around three families of alloys, namely high strength/corrosion resistant alloys, high modulus/low density alloys and elevated temperature aluminum alloys. Included is the response of these alloys to various types of processing, e.g., consolidation, forging, extrusion, and rolling. A particular area of interest encompasses development of innovative methods that lead to products with RST microstructures, but at a substantially reduced cost. Current interest areas include technology for canless billet making, spray forming processes, and processes that are capable of producing RST sheet and component shapes directly from powders of the melt.

Titanium alloy requirements through rapid solidification technology (RST) are directed to the development of alloys with improvements in three areas: temperature stability to 1400°F, strength to 210 Ksi, and higher modulus/density ratio for use in advanced engine and airframe applications. Approaches are needed in alloy development, powder making and powder compaction. A special interest is in new approaches to the innovative direct production of alloy powder, containing unique microstructure from inexpensive chemical reactants.

Because of good specific strength and stiffness, magnesium alloys are potentially attractive for many aerospace applications. Research is now needed to explore property improvements, especially in the corrosion resistance of these alloys that may be obtained using rapid solidification technology (RST). In addition, improvements in strength, stiffness, and even a reduction in density may be possible using increased levels of conventional additions and/or novel alloying additions. Approaches are needed in the following areas: development of a rapid solidification process suitable for Mg alloys, Mg alloy development, low cost consolidation techniques, and evaluation of mechanical properties.

43. TITLE: Reliable High Temperature Materials for Advanced Gas Turbines

DESCRIPTION: In Air Force turbine engines, materials are operating at or near their capacity with regard to stress, temperature and environment. Yet, it is necessary to extend the life of current systems. New systems are envisioned which will demand lighter-weight structures of extreme reliability and resistance to environmental attack or catastrophic failures. A rational basis for developing improved material systems (high temperature and refractory alloys, ceramics, or refractory composites) is required through understanding of the principles that govern properties and behavior as functions of microstructural features, composition, and processing. New approaches leading to increased performance



of high temperature alloys, ceramics or refractory composites, are required as follows:

High Temperature Alloys. Approaches to thermodynamically stable oxidation-resistant turbine engine blade, vane, and disk, alloys which offer significantly improved creep, fatigue, and oxidation properties.

Ceramics. Research to identify new families of high performance ceramics or composite materials capable of economical consolidation, reproducible processing and improved thermal stress and fracture reliability is needed to extend the limits of future generation high temperature turbine engine components.

Composites. Approaches to improved oxidation resistant carbon-carbon and ceramic composites for use above 3000°F are required.

44. TITLE: Silahydrocarbon Research

DESCRIPTION: The Air Force is interested in approaches to develop thermally stable, wide-liquid range base fluids for hydraulic fluid and lubricant use, with chemical and physical properties equivalent or superior to the silahydrocarbons (tetraalkylsilanes), (Reference 1-3) but which are capable of being synthesized by chemical processes capable of producing these fluids in the 50,000 gallon or higher per year volume range for significantly less cost than the estimated \$80 per gallon cost of the silahydrocarbon. Alternative synthetic routes must be explained and justified. For any alternative classes of fluids proposed, data or rationale must explain or show why their properties would be equivalent to the silahydrocarbons. Samples of candidate fluids synthesized must be characterized for viscosity, temperature and thermal stability properties and 250 ml samples of up to six of the more promising candidate fluids shall be submitted to the Air Force for further characterization. Ref. 1 "Synthesis and Characterization of Silahydrocarbons - A Class of Thermally Stable Wide-Liquid Range Functional Fluids," Snyder, Jr., C.E. et al., ASLE Transactions Vol. 25, 3, 299-308. Ref. 2 "Determination of Storage Stability of Hydraulic Fluids for Use in Missiles," Gschwender, L. et al., ASLE Preprint No. 83-AM-1A-1. Ref. 3 "Synthesis and Properties of Silahydrocarbon, A Class of Thermally Stable, Wide Liquid Range Fluids," Tamborski, C. et al., I&EC Product Research & Development 1983, 22 172.

45. TITLE: Protective Coatings for Aircraft Transparencies

DESCRIPTION: Protective coatings for aircraft transparencies, when subjected to thermal and environmental stress, tend to fail by peeling away from their substrate. However, a protective coating with the ability to form a gradually interdiffused boundary layer would not be expected to suffer from this defect. No clear boundary between the polymeric coating and the polymeric substrate would exist. Rather, a gradual transition in polymer chemical structure with an attending gradual transition in physical properties would be expected. Requirements exist for a polymer to serve as the basis of such a coating which would be compatible with high impact polymer substrates, (i.e., polycarbonates) possess thermal and environmental stability and have all the optical properties required of an aircraft transparency.

46. TITLE: Novel Monomer Precursor Chemistry

DESCRIPTION: High technology is needed to broaden the temperature range of high temperature, chemical, and fluid resistant compositions with potential for elastomeric application. The temperature range of -100°C to 400°C is possible within emerging technology. Specifically, the fluorocarbon ethers and fluorine - carbon - nitrogen polymer systems have the low temperature flexibility in the -100°C range and thermal stability above 300°C. Attempts have been made to prepare these types of polymers with marginal success. Novel approaches are needed for monomer precursor chemistry that will lead to a viable polymerization, yielding high molecular weight linear polymers. Initial considerations will not be limited to cost or toxicity, but these factors will need to be verified.

47. TITLE: Applications of Biotechnology

DESCRIPTION: The Air Force is interested in research and development directed toward applications of biotechnology to materials requirements. This activity can include the following areas:

Biosynthetic methods to provide state-of-the-art materials for Air Force structural, fluid, or electronic applications, utilizing resources which can be domestically produced.

Novel materials obtained from biological sources with properties which may satisfy current or future Air Force needs.

Biodegradation techniques appropriate to applications such as paint stripping or integrated circuit etching.

48. TITLE: Long Shelf Life Fiber/Resin Prepregs and Adhesive Films

DESCRIPTION: Long shelf life prepregs and adhesive films are required for use in repair of composite components at the base and field level where refrigeration may not be available and materials consumption sporadic. This requirement might, for example, be satisfied by a feasibility demonstration of the use of encapsulation techniques to prepare long shelf life prepregs and adhesive films from conventional, commercially available materials formulations. Encapsulant materials selection and wall thickness would be critical so that the materials may be mixed into the MY720 (CIBA GEIGY) epoxy resin in conventional blenders at temperatures of about 130°F to 160°F without breakdown and subsequent reaction so that shelf life is not impaired yet the encapsulant should allow normal rates of reaction to occur during cure cycles beginning at about 220 to 250°F. The materials to be encapsulated could include solids such as DADS (diamino-diphenylsulfone), Dicy (dicyandiamide) and BF<sub>3</sub>400 (MEA) (borontrifluoro-monoethylamine complex). It is imperative that the encapsulant materials not interfere with the cure of the resin or adhesive formulation nor should it degrade the mechanical properties of the cured materials. Long shelf life formulations should be prepared from the various encapsulated ingredients and evaluated for storage life at various temperatures and humidities, cure reaction kinetics, processing rheology, and mechanical and chemical properties.

49. TITLE: Processing Science of Organic Resin Matrix Composites

DESCRIPTION: The Air Force is interested in approaches towards controlling the processing of organic resin matrix composites. This research and development can include the following areas:

Characterization of the processing behavior of resins as a function of critical materials and process parameters.

Modelling of the critical materials - processing interactions.

Development of novel techniques to control the materials and processes, including in-process sensing.

Validation of results through preparation of materials and processing into material forms and composites.

50. TITLE: Synthesis of New Thermooxidatively Stable Polymer Systems

DESCRIPTION: Approaches are needed for the synthesis and characterization of thermooxidatively stable polymeric materials specifically tailored in molecular structure for new, improved matrix resins and adhesives. Included are (a) high molecular weight processable polymers exhibiting high thermooxidative stability which by virtue of chemical additions, cycloadditions or rearrangements can be cured to high strength materials, (b) polymers containing a high degree of chain rigidity which can be ordered (and/or oriented) and processed to high strength materials, (c) reactive oligomers capable of being converted to environmentally resistant, high molecular weight, high glass transition temperature materials by controlled chemical addition reactions and/or molecular rearrangements, and (d) low polymers or prepolymers which can, without the production of by-products, be cross-linked chemically and/or through low energy cures to high polymer networks with excellent resistance to thermochemical and mechanical environments and stresses. This also includes approaches to provide improved new polymer forming reactions and approaches to the synthesis of specifically structured chemical intermediates, multifunctional monomers and cross-linking agents required to produce the above polymeric materials.

51. TITLE: Organic Matrix Materials for Composite Structures for Space Applications

DESCRIPTION: The Air Force is interested in identifying and characterizing composite matrix materials for space applications. This research can include the following areas.

Identify and characterize composite matrix materials that exhibit neither moisture absorption during endoatmospheric processing, nor outgassing of trapped volatiles during exoatmospheric service conditions.

Develop new composite matrix materials that have aforementioned characteristics, and that possess epoxy-like processing capabilities.

Study the long term effects of outgassing on the dimensional stability of composite structures in the space environment.

52. TITLE: High Strength Carbon-Carbon Materials

DESCRIPTION: The Air Force has a requirement for high strength carbon-carbon composites for satellite structures, gas turbine components, and other applications. Improved shear and cross ply tensile strength in fabric laminate carbon-carbon composites is needed to provide better design flexibility with these high-temperature materials by eliminating the necessity of designing to low interlaminar strength allowables which are inherent with today's materials. This is particularly important to the Air Force in the design of gas turbine rotors and other applications where thin sections are required and the use of multidirectional weaves is not practical because of fiber tensile strength losses or coating difficulties. Solution to this problem may come from an understanding of fiber-matrix association leading to the ability to select constituent fiber and matrix materials and process them to achieve an optimum fibre-matrix association without degrading other excellent properties. The potential of new small effective diameter fibers with high strength and stiffness should also be considered.

53. TITLE: Advanced Tribological Materials

DESCRIPTION: The Air Force is interested in research to develop self-lubricating materials for use as face-riding seal materials in engines. These self-lubricating materials may be reinforced internally to meet the necessary strength requirements. The use of innovative materials and/or preparation of these materials is encouraged. The materials are to provide self-lubrication (controlled wear rate) with limited fluid leakage at rest and at sliding up to 160 ft/sec with differential pressures up to 120 psi. The fluids to be sealed would include hydrocarbon oils and oil vapors. The temperature of operation would be in the range of 20°C to 550°C. Operation of these sealing materials would generally be against a counterface of titanium, but demonstration against alternate counterfaces would be considered and encouraged.

54. TITLE: Metal Matrix Composites

DESCRIPTION: Graphite-magnesium and graphite-aluminum metal matrix composites offer significant potential for high performance light weight spacecraft structures because of their stiffness and dimensional stability. However, practical manufacturing techniques for forming materials and structures are lacking.

Innovative ideas are needed in the areas of processing concepts for making tape or sheet and of fabrication of large components.

55. TITLE: Life Prediction for Engine Materials

DESCRIPTION: Prediction of fatigue and crack growth characteristics and development of cumulative damage models for elevated temperature metals and intermetallic materials and refractory composites which consider time-dependent behavior and environmental effects are required as a basic building block for

life prediction. These models should be derived from laboratory-size specimens, with and without stress concentrations. Effects of mean stress, positive and negative stress ratios, combined stresses, overloads, rate and frequency of loading, hold time, and load sequencing need to be investigated. Effects of defects and application of threshold concepts should be considered. Particular interests are in property-microstructure relationships for materials for advanced turbine engines including nickel-base superalloys, single crystals, and aluminides and refractory composites. Approaches are needed to provide these capabilities in an economic way.

56. TITLE: Surface Modified Transparent Plastics

DESCRIPTION: Transparent materials such as the acrylics and polycarbonates utilized in aircraft windshields and windows are degraded by the aggressive conditions of exposure to the sun and atmosphere as well as by inadvertent use of fluids which tend to degrade these materials.

This requirement involves a feasibility demonstration of the use of surface fluorination as a means of preventing stress crazing and cracking of acrylic and polycarbonate transparent plastics. Process variables including fluorination levels, depth of penetration, position of the fluorine on the molecular chain of the plastic and reaction conditions shall be investigated to determine the level of chemical protection that is achievable via this process. Specimens having various levels of surface modification shall be evaluated by stressed exposure to sunlight, humidity and various aggressive solvents and chemicals and subsequent mechanical test to determine resistance to stress crazing, cracking, transparency retention and mechanical properties.

57. TITLE: Electronic Packaging

DESCRIPTION: Approaches are needed to solve microelectronic problem areas, to model and develop new packaging approaches, reliable solder materials, optimized printed wiring boards and materials with required properties, such as specified thermal expansion coefficient and low dielectric constant. Approaches are also required in the areas of materials and process development for microwave circuits packaging. Another general area of interest associated with the manufacturing of packaging materials is the area of process control (i.e. electrochemical plating and etching).

58. TITLE: Infrared Detectors

DESCRIPTION: Air Force requirements for improved infrared surveillance capabilities dictate a need for advancements in detector materials and processing technology. Mercury cadmium telluride and extrinsic silicon materials have a high potential for meeting anticipated detector performance requirements with the emphasis being on long wavelength detection. New concepts such as heterostructures and superlattice detectors are desired for the long term applications. Detector arrays are being driven to mosaic formats of  $10^3$  to  $10^6$  elements which places increased emphasis on needs for material uniformity, reproducibility, and low cost processing. New techniques such as molecular beam and vapor phase epitaxial growth are currently being evaluated for meeting these requirements. New approaches to provide additional benefits in low cost processing and detector performance are solicited.

59. TITLE: Microwave Materials

DESCRIPTION: Gallium arsenide based amplifiers and monolithic integrated circuits are finding increased use in military systems. A key for the fabrication of these microwave devices and circuits is the basic semi-insulating gallium arsenide material that is used for device substrates. Improvement is needed in several areas, including the following: the growth techniques for large, uniform crystals, the growth of low defect material, and the identification and optimization of appropriate evaluation techniques for both bulk material and wafers, the latter area includes the need for an identification of the material and wafer properties that have the greatest effects on device performance. Device and process modeling for microwave devices will aid in this identification. In addition, improved techniques for wafer preparation are needed.

60. TITLE: Artificial Intelligence in Manufacturing

DESCRIPTION: Recent advances in artificial intelligence (AI), particularly in expert systems, have resulted in capabilities to substitute machine intelligence for human decision making. In the manufacturing arena, there are numerous situations where an accessible, easy to use, and fast computer based expert system can provide substantial economic and other benefits. Of particular interest is the application of AI to the planning, scheduling and control functions of manufacturing. Additionally, applications of AI to in-process quality assurance are of interest. Systems that would be generic and adaptable to a wide range of manufactures, particularly second and third tier subcontractors, are of most interest. Development of approaches and techniques to create expert systems for manufacturing will be based upon a thorough knowledge of the needs and capabilities of second and third tier subcontractors. Examples of possible development areas are job shops scheduling, process planning, etc. Traditional computer programming techniques are not of primary interest.

61. TITLE: Aircraft/Missile Power Technologies

DESCRIPTION: Development of one or more of the following technologies is needed in the area of aircraft and missile power systems:

a. High temperature power semiconductor device with a maximum junction temperature of 300 degrees centigrade, low power dissipation, and the ability to switch 10 amps at 2.5 KW per device.

b. Advanced electrochemical power source concepts are sought that offer revolutionary improvements in energy and/or power density. Batteries are needed with the following performance characteristics:

(1) Rechargeable batteries that provide a gravimetric energy density of 100 watthours/pound, volumetric energy density of 8 watthours/cubic inch, power density of 300 watts/pound, 15-year life, 1,000 charge/discharge cycles, energy efficiency of at least 80 percent, and a self-discharge rate of 10,000 hours or slower. The size range of interest is from 2 through 5,000 amperehours.

(2) Active primary batteries for survival avionics that deliver 30 or more watthours/cubic inch and at least 100 watthours/pound at the 10-hour discharge rate with pulses at the 20-minute rate near end of life. The batteries must operate over the temperature range from -65 to +210 degrees Fahrenheit. The size range of interest is from 0.5 to 30 amperehours.

(3) Active primary batteries for ground and mobile power applications that provide over 400 watthours/pound, over 25 watthours/cubic inch, 100-hour or slower discharges, 15 years' shelf life.

(4) High power density primary reserve batteries for airborne applications that can provide peak power densities of at least 10,000 watts/pound in a pulsed mode of operation for total active lifetimes of up to 300 seconds with shelf life of 25 years and no degradation. Other parameters of interest are: activation within 1 second or less by an electrical pulse, airborne environments, operation over the temperature range from -65 to +165 degrees Fahrenheit without any external heat source, gravimetric energy of 50 or more watthours/pound, and volumetric energy density of 1 or more watthours/cubic inch.

62. TITLE: High Power for Space Applications

DESCRIPTION: Development of one or more of the following technologies is needed in the area of high power for space.

a. Lightweight energy storage capacitors with an energy density greater than 500 joules per pound per assembled device, output voltage greater than 10 kilovolts, response time less than 10 nanoseconds, and lifetimes of greater than 1.0 million pulses per device. Lightweight energy storage inductors with an energy density greater than 1000 joules per pound per assembled device, output voltage greater than 200 volts, response time less than 1.0 microseconds, and an indefinitely long lifetime.

b. Repetitive opening and closing switches for pulse power output of between 10 and 100 kilovolts and 0.1 to 2.0 million amps. Response time must be less than or equal to 100 nanoseconds and lifetime must exceed one million events.

c. High power, high voltage, high current density pulse conductors that are lightweight, high-strength, and applicable for the space environment. Pure metal conductors must be suitable for use in generator windings and magnets and able to transmit pulsed as well as continuous high power without conductor failure. Intercalated graphite conductors must be lighter weight and higher strength than copper and aluminum. Also, assembled intercalated graphite conductors must demonstrate thermal stability and improved order in the graphite filaments; must be able to transmit pulsed as well as continuous high power without conductor failure. Superconducting conductors must be able to continuously carry 150 kiloamps per square centimeter at an operating temperature above 7.0 degrees Kelvin without going normal. Dielectric insulation for these conductors must be lightweight, thermally and chemically stable for the space environment and have a voltage withstand of 20 kilovolts per mil of thickness.

63. TITLE: Advanced Optical Diagnostics

DESCRIPTION: In-situ temperature measurements of rapidly changing or rapidly moving hot surfaces such as laser irradiated targets, laser nozzles or turbine blades are of immediate Air Force interest. These situations frequently involve the surface in contact with a mixture of higher temperature flowing gases. The advent of lasers, sensitive detectors and fast microprocessing open opportunities to devise and demonstrate new fast methods of surface temperature measurement.

Some of the potential methods are fast infrared array measurements, laser induced fluorescence, and surface reflectivity. The laser induced fluorescence appears attractive in that it might be used under the conditions of most interest i.e., a hostile environment of hot gases. It is known that the laser-induced fluorescence spectra of some species show measurable dependencies on the matrix temperature. These dependencies usually are in the relative intensities of fluorescing bands. Techniques are sought to use this or a competitive method to perform rapid in-situ surface temperature measurements. Schemes such as ion-implantation may be considered providing the structural integrity of the blade or surface is not degraded.

It is mandatory that the method to be investigated have the potential of 5% relative accuracy, good lifetime under the operational conditions envisaged, ease of implementation and reasonable cost. Basic demonstration of the chosen method is required under laboratory conditions.

64. TITLE: Fuels Combustion Modeling

DESCRIPTION: Existing fuel combustion models, such as the Teaching Elliptic Axisymmetric Characteristics Heuristically (TEACH) Code, are inadequate in many respects. These models ignore the mixing that results from large scale structures. They also lack suitable chemical kinetics equations for the pyrolysis and oxidation of hydrocarbon fuels. New mixing and kinetics sub-models are needed that can be incorporated into TEACH and similar codes to improve their accuracies and to account for differences in the chemical composition of fuels. Unsteady-flow codes, based on solutions of the Navier-Stokes equations, are also of interest, as these codes promise greater accuracies and the predictions of the unsteady-flows and instabilities found in actual combustors.

65. TITLE: Turbine Engine Test Instrumentation Techniques

DESCRIPTION: An area of ever increasing concern in the turbine engine community is the accurate determination of the strains and temperatures under which engine components must operate. Advanced engine test programs are limited by the problems associated with current structural instrumentation capabilities. The state of the art of structural instrumentation has many shortcomings in both the strain gage and thermocouple areas. Current turbine engine tests are particularly impaired by the fact that present instrumentation is, commonly, temperature limited, short lived, inaccurate, and either protrudes into the gas flow stream or requires trenching the structural component in order to embed the sensor.



For these reasons new sensors/systems capable of surviving the harsh environments of a turbine engine while providing accurate strain and/or metal temperature data are required. Candidate sensors/systems should be capable of withstanding temperatures in excess of 1500° for at least 50 hours of engine test while detecting strain with at least 5% accuracy and/or temperature with at least 1% accuracy. Additionally proposed techniques should have minimal influence of blade parameters and gas flow path.

66. TITLE: Fiber Weaving for Composite Components

DESCRIPTION: Fiber reinforced composite materials offer the turbine engine designer an opportunity to design lightweight, low-cost, high-performance engines. It is critical to such efforts that inexpensive fiber forms be available. Such fiber forms may be woven mats of dry fiber or woven forms in the shape of the component. Those and other fiber forms can be useful in fabricating the components if the structural requirements of the component can be satisfied. The desired fiber weaving effort will address potential cost savings of the fiber weaving process compared to current fiber forms; the advantages of the fiber weaving process with regard to reducing fabrication costs and improving the structural design of the component; increased capability to fabricate complex shaped components; compatibility with existing processes for the particular matrix material; and limitations imposed by the fiber on the weaving process. The fiber weaving process may address compatibility with more than one matrix material, or multiple weaving process/matrix material combinations may be investigated.

67. TITLE: Advanced Ramjet Propulsion Systems Development

DESCRIPTION: The objective of this research is to conduct analytical and experimental studies of the fluid dynamics, chemical kinetics, and combustion dynamics relevant to the development of advanced ramjet propulsion systems. These propulsion systems include the solid fuel ramjet and ducted rocket for strategic and tactical missiles. Technology areas of particular interest include efficient combustion of high energy metallized fuels, throttling approaches for solid fuel ramjets, and the development of flow visualization techniques applicable to water tunnel and bare wall combustion tests. Unique ideas and approaches will be screened analytically. Promising approaches which survive the screening will then transition to experimental investigations.

68. TITLE: Space Power Systems

DESCRIPTION: Military satellite space power systems at present utilize silicon solar cell arrays, battery or fuel cell energy storage and power distribution, and conditioning in the 28 volt range and at .5 to 5 kW power levels. Future power system requirements are anticipated to be in the 10 to 60 kW range in the near term with peak requirements up to a factor of 10 or greater. Far term power requirements are anticipated to be in the peak megawatts range. Survivability and long life are required for all future missions. Technology needed to meet these requirements includes system and component technology in the 200 to 300 VDC range and all that implies in terms of interacting with the space environment and threats in all orbits. Enabling technology is needed to improve system performance, reduce weight and cost, and increase life to a

minimum of 10 years. This may include lighter weight, more efficient solar cells, higher temperature capability through elimination of soldered interconnects, and adhesively bonded cell covers; better means to survive weapon threats; and minimizing the adverse inter-actions of the solar array with the space and environment in all orbits from low orbit to geosynchronous. Fully packaged rechargeable satellite batteries are needed with the following characteristics: a) a usable specific energy of 100 watt-hours per pound under the following conditions: charge-discharge cycle life of up to 15,000 cycles, calendar life of 10 years or more, charge times of 5.25 to 22.8 hours, discharge times of .75 to 1.2 hours, and peak power capability of 1 kW per pound and b) a usable specific energy of 50 watt-hours per pound under the following conditions: charge-discharge cycle life of 30,000 cycles, calendar life of 5 years or more, charge time of 1 hour, discharge time of 30 minutes, and peak power capability of 1 kW per pound. With respect to thermal systems, research in high power spacecraft thermal management is required in the areas of unsteady two-phase heat transfer for application to power electronic cooling. Research proposals should address flow stability and heat transfer phenomenology related to zero-gravity two phase, unsteady heat exchange processes.

69. TITLE: Traction Modeling of Military Lubricants

DESCRIPTION: A program is suggested to develop a model that can predict the traction behavior of MIL-L-7808 lubricants used in rolling element bearing analysis. A large data base of traction profiles (traction coefficient vs slide/roll ratio) has been developed on a number of military lubricants using a two-disc type tester operating at various loads, temperatures and rolling speeds. This program would use the data base to develop a reliable traction model to be used in bearing programs such as Dynamics of Rolling Element Bearings (DREB) and Tribo 1.

70. TITLE: Turbine Engine Lubricant Screening Tests

DESCRIPTION: The lubrication of most aircraft engines relies on the use of stable ester-based fluids. Adequate test methods are available to determine the lubricant condition during use. However, additional development effort is needed to provide enhanced laboratory evaluation procedures and improved models of in-service degradation for the assessment of experimental lubricants.

71. TITLE: Logistics R&D: Space Defense-Material Sources

DESCRIPTION: Support of a space based defensive system may require the processing and fabrication of material to build the space based components. Conceptual research is needed to determine the source or combination of sources of material. Current budgetary estimates indicate conventional, terrestrial sources would be prohibitively expensive. Some earlier studies suggest that lunar or asteroidal material may be useable. Concepts of ways to meet material requirements for a space based defense against ballistic missiles should be developed in the research.

72. TITLE: Chemical Warfare Defensive Equipment

DESCRIPTION: The USAF has a continuing need for advanced concepts and equipment concerned with personal protection of aircrew and groundcrew against

exposure to chemical warfare agents. There is a need for fieldable technologies for point detection and measurement of chemical agent vapors in air. Specific needs include (1) sensitive and selective reagent systems for colorimetric, fluorescent, chemiluminescent and other chemical enzymatic techniques for measuring nerve and blister agents, and (2) reagent packaging systems such as agent-active chemically impregnated film and tapes, coating on fiber optics, etc., on which to base development of electro-optical monitoring devices and industrial hygiene type dosimeters. General needs are for small, highly sensitive detection devices for aircraft cockpit applications, and an indicator to warn that CW-agent filter protection is about to end. There is a need for a chemical agent filter for complete removal of CW-agent vapor and aerosol from breathing gases. The filter must be small and lightweight to be worn by aircrew and groundcrew, must have universal capability to stop passage of all known types of agents, and must show reduced breathing resistance over current generation breathing filters. There is a need for development of improved chemical agent decontaminants for personnel. Various decontaminant sprays, powders, etc., cause harmful effects when employed directly on skin and clothing. This research would lead to effective decontaminants for nerve, blood and blister agents which have no harmful side effects when used on skin or on permeable clothing.

Examine and develop chemical compounds for applicability in don/doff experimentation. The ideal simulant would have the same physical characteristics as any one of the chemical warfare agents. The characteristics of concern are disseminability (viscosity), off gassing (volatility), and the ability to be mechanically transferred and decontaminated (surface tension and chemical activity). In addition, the compound should be detectable in small quantities by standard chemistry practices, and should not be interfered with by commonly occurring environmental conditions. In addition, the simulant should be virtually non toxic to human skin and eye respiratory systems. Alternate projects in this area should examine detection methods for simulants currently in use.

73. TITLE: Enhancement of Operational Aircrew Capability

DESCRIPTION: The USAF School of Aerospace Medicine (USAFSAM) is seeking innovative research and/or engineering development yielding products which will enhance the capability of operational aircrew. The major areas of interest are: (1) unique selection techniques which will identify the top 20% of the operational aircrew pool; (2) unique training techniques which will train those superior operational aircrewmen to the point where each is a 99th percentile pilot; and (3) unique approaches to the pilot-aircraft interface, with particular reference to closer coupling of man and machine, and with a stronger biological basis for the design of that interface.

The USAFSAM interests at this announcement are global. Research proposals can address sensory mechanisms/enhancement, motor mechanisms/enhancement, and cognitive mechanisms/enhancement. Disciplines from which proposals are invited include sensory and psychomotor psychology, human performance and/or human engineering psychology, neurophysiology, psychophysiology, neurochemistry, physics, engineering, computer sciences, and the health sciences.

74. TITLE: Optical Signature Simulation/Optical Pen Aid Effectiveness Codes

DESCRIPTION: The optical signature code (OSC) used by BMO/SYMP provides detailed information and predictions pertaining to the optical signatures of reentry vehicles (RV) and penetration aids in the exo-atmospheric regime. In order to further enhance the usefulness of the OSC, a generalized scenario of critical inputs to the code is required. These inputs consist of penetration aid/RV mix and deployment conditions, most probable trajectory definition, and environmental conditions definition. The scenarios defined would represent actual targeting conditions as opposed to flight test conditions, and would be used in effectiveness assessments of optical penetration aids. The research chosen would develop the actual input scenarios to the OSC.

75. TITLE: Implication of Open Data Releases on Strategic ICBM Systems

DESCRIPTION: An understanding of the value to an opposing intelligence service of the data released through open sources and test shots into Kwajalein is required. The value to the US of revealing or denying such data must also be around. Based upon the values as defined a prioritized list must be developed for the specific data elements which should be held closely.

76. TITLE: Active and Passive Electronic Modification of Ballistic and Manuevering Reentry Vehicle Signatures

DESCRIPTION: Innovative active and passive techniques for the modification of reentry vehicle signatures (body and wake) shall be addressed. The study can include application of these techniques on both ballistic and manuevering reentry vehicles. Theoretical approaches will be pursued to select promising concepts that may be able to avoid enemy defenses through electronic deception techniques. Studies will address theory behind approaches, packaging, power requirements and preliminary effectiveness analyses.

77. TITLE: Study of Anti-Simulation Techniques Applicable to Ballistic and Manuevering Reentry Vehicles and Associated Penetration Aids

DESCRIPTION: Study should include analyses of ballistic and manuevering reentry vehicles and associated penetration aids incorporating anti-simulation techniques. Analyses should identify those observables which may best be modified by these techniques and the applicable range of observables required to increase the penetration effectiveness of the reentry vehicles.

Effectiveness analyses must be incorporated against realistic threats. Innovative approaches to anti-simulation techniques will be explored.

78. TITLE: Wake Modification of Ballistic and Manuevering Reentry Vehicles and Associated Penetration Aids

DESCRIPTION: Innovative techniques for suppression of reentry vehicle wakes and/or the enhancement of the associated penetration-aids wakes should be examined to address basic chemistry issues of possible quenchants and/or enhancers and their application. The injection and/or mixing of these materials into the wake must be addressed to optimize their effectiveness. Techniques sought could include active and/or passive methods of introducing quenchants and/or enhancers to the wake.

79. TITLE: Optical Masking by Means of Expulsion of Materials

DESCRIPTION: An in-depth analysis of an optical masking technique which employs expelled materials is desired. The analysis should concentrate on development, verification and extension of computer models based on available flight test data. Limited ground testing may be required.

80. TITLE: Optical Sensor Inhibition Techniques for Ballistic Missile Defense Systems

DESCRIPTION: Innovative techniques for the suppression or inhibition wideband of BMD optical sensors are required active, passive (including RV and penetration aid OCM coatings), and tactical methods should be exploited.

81. TITLE: Effects of Noise on Discrimination of Decoys

DESCRIPTION: A study is required to evaluate the degradation of a defensive radar's ability to discriminate decoys from reentry vehicles when an under-populated cloud of jammers provides a noise field between the radar and the hard objects. Provide a model for estimating equivalent K-factor (where  $K = \Delta\mu/\sigma$ ) as function of signal to noise. Consider alternate means for improved threshold selection in this scenario and compare the resulting  $P_L$ ,  $P_{FA}$  statistics.

82. TITLE: Active Chaff

DESCRIPTION: Chaff has proven to be an effective exatmospheric penetration aid for ICBM applications. A primary problem with chaff is a slow-down in velocity as the chaff reaches denser atmosphere. This slow-down allow radars to "see into the chaff" and detect RVs which are moving at a higher relective velocity to the chaff elements. The application of elements which return radar energy in the required doppler spectrum could make the chaff effectiveness independent of its real velocity.

A study is needed to perform the following tasks: (1) Determine the minimum size and weight of a half wave length dipole (frequency to be determined) which has a "make-break" electrical connection at its midpoint. The "make-break" frequency (doppler spectrum) is controlled by a random rate multivibrator. (2) Determine the amount of power required to operate this device as a function of time with a 10% duty cycle over an elapsed time of 30 seconds to 30 minutes. (3) Determine the change in size and weight to add the stored power (as a function of time) to the chaff element. (4) Determine the feasibility of acquiring the operating power from the incident radar energy.

83. TITLE: Radar Suppression Techniques for Ballistic Missile Defense Systems Sensors

DESCRIPTION: Innovative techniques for the suppression of BMD radar sensors are required to enhance expected penetration and kill probabilities of US reentry systems. Techniques sought could include active, passive, and tactical methods. An example would be a vehicle which generates EMP near to and directed at the radar. The contractor should evaluate vehicle weights or weight impacts (mods to existing vehicles), damage mechanisms, and technology limits.

Recommend technology programs for technology-limited aspects of the system design.

84. TITLE: Optimum Navigation

DESCRIPTION: The introduction of "Smart" RVs suggests an ability to counter effectively a wide variety of targets under extreme operating conditions with warheads of dramatically reduced yield. This new class of RVs is expected to be equipped with a terminal homing capability and will require new navigational laws. It is further suggested that optimal energy management could result in significantly reduced control weights/volumes and, thereby, potentially offset similar increases required for the RVs intelligence.

85. TITLE: Ring Laser Gyro (RLG)

DESCRIPTION: An area which needs development effort is the RLG operation in a nuclear environment. The RLG differs from spinning mass gyros in that it has no memory to allow recovery in the nuclear environment. This study should investigate the technology effort required in the area of circumvention, recovery and hardening of the RLG.

86. TITLE: Small Lightweight Hardened Guidance Computer/Component

DESCRIPTION: The Peacekeeper computer was designed for production using current (1983) radiation-tolerant semi-conductor components resulting in a heavy, relatively large and high power consumption assembly. As a result the Peacekeeper will not satisfy advanced booster requirements. This study should investigate the feasibility of developing a small lightweight radiation hardened low power computer for missile navigation guidance and control.

87. TITLE: Hemispherical Resonator Gyro (HRG)

DESCRIPTION: This task will evaluate the accuracy levels for quick reaction gyrocompassing in ballistic missile application. Accuracy, error sources and nuclear hardness must be characterized.

88. TITLE: Economical Geotechnical Exploration Concepts

DESCRIPTION: The ability to economically determine geologic properties is important to the Deep Basing Program. Geologic properties data, for some regions of interest, does not exist. Development of a system or systems to quickly and inexpensively measure in-situ material properties down to depths of several thousand feet and to "see" significant distances ahead of a tunnel face to ascertain geologic conditions along a tunnel alignment is needed. These measurements are currently best obtained through vertical and horizontal drilling and are thus very expensive. Material characteristics of interest include rock strength, stiffness, fracturing, and deformation properties. These characteristics may be measured conditions. The degree of precision needed will vary depending on the property and the geologic screening process involved. Thus, the cost and time required to acquire data versus the precision of measurement of the data will be an important consideration.

89. TITLE: Tunnel Closure Concepts

DESCRIPTION: A deep based missile complex will require closures to seal portions of the complex to provide physical security of critical assets, separate environmentally controlled areas from non-controlled areas, provide blast protection, and close off active egress paths. This research could identify innovative closure concepts capable of quick opening/closing capability, providing clear tunnel cross section when open, hardening to nuclear weapons effects, minimize cost, and high reliability. Development of a workable closure concept is essential to survivability of a deep base.

90. TITLE: High Altitude Synthetic Aperture Radar (SAR) Operations

DESCRIPTION: The use of SAR to support ballistic missile application requires the parametric development of envelop/boundaries for trajectory, altitude and pointing, velocity, and SAR foot-prints. Additionally target-signature/sensor-matching methodologies need to be developed to accomodate signature type, propogation phenomenology, discrimination input factors, and multisensor utility. Lastly, on-board equipment need to be addressed in terms of sizing, on-board processing, C<sup>3</sup> and fuzing.

91. TITLE: Search Algorithm for "Intelligent" Reentry Vehicles

DESCRIPTION: "Intelligent" RVs have the capability to search large intercept volumes for a target and then track/guide to the target. At a higher level of sophistication, the RV could conceivably classify individual targets within an intercept volume, order the targets according to some priority criterion, and attack the targets in order of the priority. The impact of this operational mode on the sensor search algorithm and the interaction with, and handover to, the track mode/algorithm needs to be definitized and the consequent impact on sensor design determined. Dedicating the search/target assignment function to an intelligent bus is of particular interest.

92. TITLE: Three-Color Optical Pyrometry Temperature Measurements

DESCRIPTION: Temperature measurements of reentry vehicle materials in ballistic range ground testing have been plagued with uncertainties in emissivities, difficulties in looking through boundary layers, and inadequate resolution. The objective is to provide a reliable measurement of true temperature through the use of three-color optical pyrometry. The pyrometer system should be capable of measuring temperatures from 800-6000 °K with response times of 2-10 nanoseconds. The spatial resolution should be less than 0.1 in over an area of approximately 1.5 in<sup>2</sup> (reductions in area coverage are acceptable). The study should include development of data reduction algorithms to provide temperature maps of the test article to the analyst.

93. TITLE: Low Altitude Dispersal Techniques

DESCRIPTION: There has developed a need for a method to disperse up to 1000 small objects of approximately 10 lb. total weight from a small reentry vehicle at low altitudes. A study is needed to define various feasible concepts such as explosively expelling the objects from the base region of the vehicle. The

study must address the aerothermodynamic implications of different techniques on vehicle design and electronic packaging of the vehicle and its payload section.

94. TITLE: Near Field Effects of Microjammers on the ABM Radars (WEEDS)

DESCRIPTION: Defense suppression penetration aid devices that use radar homing guidance to place the device near or at the radar may be susceptible to countermeasures. The following study is required: Using projected defensive system threat definitions, evaluate degradation of radar performance when various numbers of small low-power jammers continue operating after falling to the ground very near the radar. Provide power-distance-noise relationships including the effects of local terrain and clutter fences of various heights and distances from the radar.

95. TITLE: Localization of Ground Mobile Targets

DESCRIPTION: Advanced ICBM designs exploit the concept of mobile basing. An effective offense against such relocatable targets is closely coupled to the ability to identify and localize them on a continuing basis. Sensors are available which can detect mobile missiles which are either a) in the open or b) accessible to viewing at shallow angles (e.g. sitting along freelines). Current sensing techniques cannot detect targets under foliage or in weather. The objectives of the program include: 1) development of a fundamental understanding mobile targets signature issues; 2) identification of techniques for distinguishing postulated signatures from surrounding environment; 3) establishment of measurement concepts exploiting such techniques and; 4) evaluation of countermeasure potential. Such a solution should address technical and programmatic issues as well as being acceptable under current treaty restraints.

96. TITLE: Design for RV Antenna Window Interaction and Plasma Attenuation Experiments

DESCRIPTION: The objective of this research is to design innovative ground test experiments to assess RV antenna window thermal and ablation response, and signal attenuation through the shock layer and boundary layer. These experiments shall utilize existing ground test facilities such as arc plasma jets, rocket exhaust facilities, or ballistics ranges. The ground test design should be based on careful quantitative analysis of the appropriate similitude requirements, flight conditions, and available ground test conditions. In the case of antenna window testing, attention should be focused on simulating quantities affecting interaction of the window material with adjacent heat shield materials. Non-similar boundary layer effects and other sources of ablation contour irregularities should be evaluated. For the plasma attenuation test design, the electron concentration profile, collision frequency, and shock and boundary layer thicknesses for flight conditions should be evaluated. If it is not possible to simulate these, simulation of appropriate products should be assessed. Owing to the difference between flight and available ground test conditions, it is anticipated that the ground test fixtures may look substantially different from flight hardware, and that highly innovative test model designs and instrumentation will be required.



97. TITLE: Transpiration Cooled Nosetip Flow Calibration

DESCRIPTION: The transpiration cooled nosetip (TCNT) is an actively cooled nosetip which ejects a liquid coolant through hundreds of small ports distributed uniformly over the face of the nosetip. These tips have a small radius (0.3 in) in either a hemispherical or flat-face configuration. Calibration measurements of the coolant flow need to be made over annular and circumferential sections of the tip. Details of typical geometries and coolant flow rates (with measurement accuracy goals) will be provided by the BMO to interested contractors.

98. TITLE: Flexible Radiation Shields

DESCRIPTION: Future decoys for Maneuvering Reentry Vehicles (MaRV) will be made inflatable so that they can be stored compactly and then expanded to full size upon deployment. These inflatable structures will require a flexible external shield (overlay) for protection from hostile encounters. For decoy credibility it may be desirable to use the same flexible overlay on the MaRV, although current MaRV overlay designs are a rigidized material.

The flexible overlay material will be subjected to bending during packaging and storage and to stretching during inflation, normal flight, and hostile encounter. The response during hostile encounter will include large deflections and shape changes. Currently available flexible overlay materials have been fabricated and tested in small quantities using available materials originally developed as reinforcements for rigidized overlays.

The decoy and MaRV designs should be reviewed to identify material requirements, including such qualities as strength, stiffness, X-ray cross-section, thermal and electrical conductivity, crease-resistance, etc.

99. TITLE: Hypervelocity Ground Test for ITP Program

DESCRIPTION: The ITP Program needs to develop a method of full scale ground testing for the ITP reentry vehicle. Since this requires speeds in excess of 10,000 ft per second, it is beyond the state of present technology. The proposals should address ways to achieve the velocities required for ITP, while staying in the realm of ground test costs. This is needed to confirm total reentry vehicle full scale performance before ballistic flight test.

100. TITLE: Laser Damage to RV Antenna Windows

DESCRIPTION: In general, reentry vehicles have a high laser hardness because of their design for high heat fluxes, reentry aerodynamic loads, and nuclear encounters. However, antenna windows may be particularly susceptible to laser attack because of the high transparency of typical window materials for some of the laser wave lengths of interest. This will allow the laser energy to reach antenna components which are not normally exposed to high temperatures. This suggests that a program to investigate the laser vulnerability of antenna windows is required.

The objective of this study is to determine the hardness of typical RV antenna windows and components to laser exposure, including both continuous wave and pulsed lasers, and to identify hardening techniques if needed. Typical antenna window designs should be evaluated for laser hardness using analysis and the existing data base. If material data, such a transparency, does not exist for the materials at laser wave lengths of interest, it should be generated.

101. TITLE: Exploitation of Tactical Warfare Technology for Strategic Warfare

DESCRIPTION: A broad range of technologies have been developed for advanced tactical weaponry. It could prove quite valuable to explore the application of these technologies to ballistic missile warfare, e.g., non-nuclear weaponry, special radars for detecting armored vehicles. The technology should take a ballistic delivery system as the baseline and then expand on the system.

102. TITLE: Target Assessment Damage by Ballistically Delivered Sensors

DESCRIPTION: Accurate damage assessment is critical for targeting second wave launches. Properly delivered sensors can provide needed information for this purpose. One method worth exploring is the use of an RV to dispense sensors in the target area after the remaining RV's have penetrated.

103. TITLE: Ablative Material Surface Roughness Characterization

DESCRIPTION: The surface roughness of ablative nosetip and heatshield materials has a substantial effect on boundary layer transition, and heat, mass and momentum transfer. A fundamental understanding of ablative material surface roughness development, leading to an a-priori prediction capability for the size and shape of the roughness elements, is needed. This may be derived from simple experiments which isolate causative effects and/or analysis of available data and the physical processes involved. For conditions where some form of blowing and/or transpiration is present (e.g., ablation or active cooling), the transpiring materials are subject to turbulent diffusion amongst the elements constituting the surface roughness. The phenomena associated with the roughness and the transpiration then interact to dictate the convective environment. In certain instances (e.g., the missile reentry environment), the gasdynamic boundary layers are very thin so that protuberances in the micron size range and larger can provide significant convective augmentation. The levels of augmentation influence system drag and dictate the amounts of thermal protection material (ablative material or transpirant) required. It is difficult to create representative boundary layers in ground test that can be sufficiently instrumented to quantify the effects of surface roughness. Therefore, a need exists for establishing an analytical technique for incorporating these effects into a methodology that can be applied with a high level of certainty to the real flight environment.

104. TITLE: Active Cooling Mechanisms for Reentry Vehicles

DESCRIPTION: A number of techniques exist for actively cooling intensely heated surfaces. However, in the missile reentry environment, it is extremely difficult if not impossible to instrument with sufficient detail to quantify the significance of the controlling cooling mechanisms. In certain instances, the cooling mechanisms themselves are dictated by the environment to which the surface is exposed (e.g., pressure and temperature effects on condensed phase materials). Certain emerging missions may be possible only through application of active cooling schemes. Thus, it is important to understand the cooling mechanisms and be able to quantify them in order to design an advanced system that will survive the environment to which it is exposed. Available cooling techniques need to be reviewed, existing data need to be critically evaluated, and critical experiments defined that will provide data that may be incorporated into analytic models to quantify the utility of the cooling techniques.

105. TITLE: Management of Ground Water Flow for Deep Underground Tunnels

DESCRIPTION: Water management is a major consideration in underground operation. A deep based system may be located in a geologic formation below the existing water table. Should this condition exist, water management methods must be employed during construction, peacetime operation, and under post attack, buttoned up conditions. Water management may involve sealing water from the deep base or disposing of it after it enters. Since the deep based system must continue to operate after a nuclear attack, techniques for water management during system operation must be as survivable as the system itself. The objective of this effort is to define the feasibility of water management concepts and to develop reliable methods to alleviate sudden inflow due to ruptured liners after a nuclear attack. These data should allow determination of the amount of ground water that can reasonably be accommodated for use in defining geologic screening criteria. Methods should incorporate innovative handling of simultaneous breaks with a minimum dependence on crew availability.

106. TITLE: Explosive Excavation Methods

DESCRIPTION: The conventional excavation method for driving drifts and tunnels in hard rock conditions utilizes some form of explosives. This method offers considerable flexibility in meeting the challenges of geologic, geometric, and other excavation requirements, but because of its cyclic nature (drill, load, blast, muck), it suffers in advanced rate and is generally inhibited from any significant improvements. Inevitably, this method is compared -- usually with unfavorable results -- to highly mechanized tunnel boring machines TBM. Further consideration of explosive excavation techniques should be encouraged because, unlike the TBM, explosives are not very sensitive to variations in rock hardness, often provide the most efficient concentration of energy into rock fracturing, and are not restricted in excavating variations in tunnel geometrics. Post attack excavation for egress using explosives could reduce the need for heat sinks, eliminate the need for large power cables and hydraulic lines to operate TBMs, and increase the potential to excavate structurally disrupted bedrock. Several study efforts to devise explosive excavation methods have been accomplished in the past, but currently there is little or no activity in advancing these

studies. Innovative approaches to improving explosive excavation techniques could improve the viability of a deep base.

107. TITLE: Impact of Directed Energy Weapon (DEW) Deployment on Penetration Aids

DESCRIPTION: Examine the implications of DEW threats of penetration aid effectiveness. The study should include passive and active decoys, chaff, and the defense suppression vehicle. Survivability and reduction in mission effectiveness will be addressed. The threats, gross vehicle characteristics (size, external material, and first order functional description), and chaff deployment parameters will be provided by the BMO. Potential means of reducing vulnerabilities (to include denying acquisition, pointing, and tracking) should also be identified.

108. TITLE: Laser Hardening External Protection Material (EPM)

DESCRIPTION: In the 1990 to 2000 time period there is a possibility that a high energy laser (HEL) may be developed which could be used to intercept US ICBMs during boost phase unless appropriate countermeasures are taken. One such countermeasure is the addition of EPM which would provide laser hardening in addition to its nuclear weapons effect role. The objective of this activity is to investigate hardening countermeasures to space or ground based HELs.

109. TITLE: Directed Energy Weapons Effects Phenomenology

DESCRIPTION: The phenomenology behind materials and electronics interactions with certain threat size class directed energy radiation fluences is not fully understood. As a result, the effects of directed weapons threats on present and future intercontinental ballistic missiles and other systems cannot be accurately predicted, so that possible failure modes and overall system survivability cannot be properly assessed. A study is required to provide a first order determination of this phenomenology. Study results will be used in the determination of test requirements.

110. TITLE: Heatshield Performance Evaluation

DESCRIPTION: Reentry vehicle heatshields limit thermal penetration through the combined effects of ablation and the insulative properties of the heatshield material. Ablation performance is dictated in part by the surface roughness characteristics in response to the adjacent aerothermal environment. A wide variety of disciplines is involved in the design of a heatshield, prediction of its performance, and evaluation of its behavior in flight. The end effect of a shortfall in any of these areas is the apparent need for excessive heatshield materials to account for design contingencies. In order to reduce the current design margins so as to achieve higher payloads, it is essential that available data be brought together and assessed in light of the predictive techniques that are being employed to design the heatshields. The need is to assemble and critically evaluate the broad range of existing data, document the results of the survey and analysis for use by the technical community, and provide a rationale for and procedure that leads to the reduction of design margins.

111. TITLE: Hardened Composites for Space Vehicles

DESCRIPTION: Advanced composites such as graphite epoxy and Kevlar epoxy have exceptionally high strength-weight and stiffness-weight ratios in the direction of the fiber reinforcements. However, their transverse properties, which depend primarily upon the stiffness, strength, and fracture toughness of the matrix material, are not as good. Current matrix materials such as epoxy, polyimide, and phenolic tend to be relatively brittle. Materials with greatly improved toughness, such as polybenzimidazoles, have been under development. These materials have now been fabricated in sufficient quantities to permit property measurements and assessment of their potential for reentry vehicle and booster application for weight saving and hardness improvement.

The objective of this study is to review the properties of advanced resins and identify those offering the greatest improvements in weight and performance. A review of new resins being developed in Government and other laboratories should be made to identify those which are sufficiently developed to warrant various reinforcements for typical booster and RV applications to determine their potential for weight saving and improved hardness. The better materials should be identified.

112. TITLE: Hardened, Lightweight Aft Cover Design

DESCRIPTION: Present designs of aft covers of reentry vehicles may not be suitable for higher levels of exposure, which are anticipated in the future. A study is needed which will define those parameters which are crucial to the design of RV aft covers at higher levels of exposure. The study should also evaluate advanced materials such as metal matrix composites, super plastic alloys, and hybrid composites for RV suitability.

Possible parameters to be investigated are 1) material characteristics, such as stiffness, ductility, and fracture toughness, 2) geometry parameters, such as shape, thickness and discontinuities, and 3) response mechanisms, impulsive or thermostructural response.

The study should identify aft cover designs incorporating materials and design features offering increased hardness against nuclear effects at lighter weight. The study should also identify design requirements such as hostile exposure, reentry loading, penetrations, and attachments. Possible design configurations, including those with advanced heatshield and substructure materials, should be postulated and evaluated to determine which parameters are most important. Attractive design approaches should be identified.

113. TITLE: Resolution Requirements for Strategic Targets

DESCRIPTION: In support of Ballistic Missile Office activities related to "intelligent" ballistic missile systems, a description of strategic targets in terms of resolution required for detection, identification, classification, recognition, etc. is required. These data, when combined parametrically with the time line associated with typical employment scenarios, could provide both processor size and processing speed requirements. Coupled with assessments of

current (and projected technology,) feasibility/viability of proposed hardware concepts could be assessed.

114. TITLE: Fast Launch ICBM Technology Requirements

DESCRIPTION: Studies are underway to determine the conceptual feasibility of ICBM's using fast launch and/or short boost time tactics to achieve basing survivability and to inhibit boost and midcourse phase targeting activities from adversary nation space surveillance systems. This study will help determine technology requirements relevant to fast launch/short boost time concepts.

115. TITLE: Fiber Optic Technology

DESCRIPTION: Examine the luminescence and absorption characteristics phenomenology for light generating, transmitting and receiving components under radiation conditions encountered in ICBM environments. Devise the technology to reduce the radiation effects on the fiber optic system by:

- a) evaluating new materials
- b) developing detection circuitry
- c) signal transmitting
- d) developing signal format that will reduce vulnerability

116. TITLE: Space Systems Vulnerabilities

DESCRIPTION: As a result of current and ongoing studies, it is apparent that space is becoming more of an important strategic arena. One aspect of this reliance on space assets is the vulnerability to direct attack or to disturbances in the intervening atmosphere. This study should consider the spectrum of vulnerabilities of space systems incorporating a variety of C<sup>3</sup> or of space sensor type systems. Vulnerabilities include effects due to direct and indirect attack as may result from a direct assault on the space platform and/or nuclear disturbed regions in the intervening media (i.e. nuclear debris, Van Allen disturbances, upper atmosphere etc.).

117. TITLE: Survivable Gages for High-Level Blast Environments

DESCRIPTION: The gages used to measure stress on silo components during simulated nuclear explosions tend to fail at the blast overpressure levels of today's tests. New measurement tools to determine silo structure response in these extreme environments are required.

118. TITLE: Unique Signal Devices

DESCRIPTION: Unique signal devices (USDs) are used to insure the missile and warhead cannot function without receipt of a valid command code. Present devices are heavy, slow, expensive, and have hundreds of small moving parts. A reliable USD capable of passing nuclear surety criteria is needed.

119. TITLE: Investigation of Non-Nuclear Hard Silo Kill Mechanisms

DESCRIPTION: The BMO Hard Silo program is examining ways to harden missile silos against nearby nuclear bursts. However, possible ways of disabling a silo-based missile other than nuclear weapons should also be addressed. A "Red Team" approach to this problem might be useful. Some of the possibilities for investigation would include:

- hypervelocity projectiles
- space-based lasers or neutral particle beams
- non-nuclear explosives used in conjunction with highly accurate surface or earth penetrator delivery.
- radiation-induced kills through use of enhanced radiation warheads instead of the usual blast overpressure kill from thermonuclear fission-fusion-fission weapons.

The study should address the likelihood of such threats occurring during the 1990-2010 time period as well as the technical feasibility of the threat.

120. TITLE: Definition and Assessment of Physical Security Threats to Small ICBM Basing Systems

DESCRIPTION: A requirement exists to define and assess potential physical security threats to the small ICBM Hard Mobile Launcher (HML) as posed by terrorist/paramilitary groups and counter against these threats. Threat definition should characterize potential threats based on review of existing documents which summarize past terrorist activity at home and abroad. Threat considerations should range from theft to destruction. Characteristics should include likely numbers of people per group, types and capabilities of weapons, types of tools/demolition equipment, kinds of transportation, tactics/method of operation, and other conditions to include day and night operations. Primary inputs to this study would include the Strategic Air Command's concept of operation for the small ICBM, the Ballistic Missile Office's threat definition to the small ICBM, the Ballistic Missile Office Small ICBM System Threat Assessment Report, and summaries of terrorist activities. Based on the contractor's threat definition and assessment, methods should then be recommended to guarantee a very high level of protection against these threats at a reasonable cost. Emphasis should be on discovering new, cost-effective concepts, based on innovative application of state-of-the-art technology including shields, intrusion sensors, electronic/laser fences, operational procedures, etc.

121. TITLE: Reactive/Response Threat Intelligence Indicators

DESCRIPTION: Establish a documented data base which contains all-source evidence specifically related to reactive/responsive threats against Peacekeeper, the Small ICBM, and advanced missile basing concepts. Emphasis should be placed on hard silo and deep underground concepts. The proposed effort involves the development of data base search profiles and assessment of threat capability in selected areas of relevant applied technology and development.

122. TITLE: Composite Erosion Test and Model Development

DESCRIPTION: Establish a comprehensive thermal and erosion data base for selected reentry vehicle materials and associated independent response models. These data should be for materials postulated for use in the production of specified threat reentry vehicles. Based on an analysis of thermal properties, controlled ablation tests, and erosive testing, performance of these vehicles in flight environments can be characterized to assess erosive resistance.

123. TITLE: Projection of Soviet ICBM and SLBM Accuracies

DESCRIPTION: Project Soviet ICBM and SLBM accuracies for the year 2000 and beyond based on analysis of telemetry, radar, infrared, and other available data. In particular, this analysis should assess the projected accuracies of the SS-18 Mod 4 ICBM and new ICBMs under development as well as the SS-N-20 and advanced SLBMs. This study should be limited to ballistic trajectories with no consideration of maneuvering RVs.

124. TITLE: Assessment of Surveillance Information Cycle Time for Small Mobile Systems

DESCRIPTION: The small mobile missile system achieves survivability by denying knowledge of location of the individual missile to the enemy. The time a missile can "park" at one location or garrison depends on the time required by the enemy to find and target it. The concept is based on the assumption of a significant time lag in the surveillance/targeting process. This study will project surveillance capabilities and information processing and retargeting capabilities based on technology projections for the mid-1990 to 2000 time period. Based on this projection and a description of the system and concept operations, an assessment will be made of the timelines for retargeting which could be achieved by a potential attacker in the 1990s and beyond.

125. TITLE: Effect of Cloud Cover on Surveillance of Mobile Small ICBM

DESCRIPTION: Based on historical cloud cover data for proposed Small ICBM deployment areas, determine the effect of cloud cover upon Soviet satellite based photo sensors attempting to detect and identify the various proposed Small ICBM mobile launcher systems. Study should parametrically consider the percentage of cloud cover, satellite altitude, sensor resolution capability, amount of daylight, and other factors such as dust, haze, and ground fog. Study would statistically model all proposed sites, both individually and collectively, so as to determine sensor degradation. Size and shape of the candidate launch systems will be an important consideration.

126. TITLE: Mechanical Application Technology of Ablative Barriers on Radome Substructure at Millimeter Wave Frequency Operation

DESCRIPTION: This would be a study of techniques for applying thermal ablator coatings and environmental barriers to radome structures consisting of cast silica ceramics as well as various fiber and plastics laminates. The informal and environmental protection with minimum attention of radio frequency energy at millimeter wave frequencies greater than 20 GHz.



127. TITLE: Rain Effects on Radio Frequency (RF) Propagation

DESCRIPTION: Conduct a study to determine the effects of rain on RF propagation over the frequency spectrum of UHF to EHF frequency bands. The study should characterize the spatial and temporal aspects of rain and characterize all propagation effects such as attenuation, phase, group delay, etc. Numerous studies have been previously conducted on this subject and vast amounts of data exist in this regard; however, a wide range of uncertainty exists and the communications system designer is confronted with conflicting data. Using existing rain propagation data, it is possible to show any condition from complete link outage to one of minimal or no effect. The subjectiveness of existing data does not take all studies and analyses into account and leaves the satellite communications designer with inadequate data. This study should pursue the principal objective of collecting, compiling and correlating all existing obtainable data and, using the latest analytical techniques, analyze rain effects and establish a design handbook to aid communication system design.

128. TITLE: Nuclear Scintillation on RF Propagation

DESCRIPTION: Conduct a study to determine the nuclear scintillation effects on satellite RF propagation to ground terminals in the 7-8 GHz and 20-40 GHz frequency band. The study should characterize the fade depth, fade rate, and fade duration aspects of scintillation and shall have, as a primary objective, the problem of resolving major differences between existing scintillation studies. This study will be based on Defense Nuclear Agency's (DNA) latest work/mathematical models for nuclear scintillation and shall develop system design requirements for scintillation for the RF frequency band specified herein.

129. TITLE: Remote Sensing of Meteorological Parameters

DESCRIPTION: The purpose of this effort is to develop spaceborne sensors capable of providing data on the meteorological parameters necessary to accomplish the mission of the Defense Meteorological Satellite Program (DMSP). Listed below are the meteorological parameters for which improvements over the present capability of the DMSP sensors are desired. The present DMSP capability and eventual goals are both listed. An improvement of 30-40 percent or more over present capabilities in the areas listed would be of interest.

While sensors currently in use by DMSP provide much useful data, improvement in the capability of the sensors is desired. The accuracy of data provided in DMSP is a limiting factor in operational support of DOD forces and the making of accurate and timely weather forecasts. Any improvement in DMSP sensors would permit an improvement of weather forecasts.

New measurement techniques or approaches, and improvements in critical sensor components, subsystems, and proof-of-concept sensors for use on future DMSP spacecraft are desired.

130. TITLE: Optical Signal Processing Technology Survey

DESCRIPTION: The advent of gigabit-per-second digital communication signaling speed threatens to outstrip what is presently the domain of complementary metal oxide semiconductors (CMOS) and very large scale integration/very high speed integrated circuits (VLSI/VHSIC) technology. Before GaAs technology is able to extend silicon solid state technology into the gigabit speed era, electro-optical digital signal processors may come of age and may open up new areas to the field of communications signal processing, not readily accomplished otherwise. Specific areas which need investigation for applicability and development are and include:

1. Matrix signal vector and multiplication and inversion. The immediate needs and applications include signal nulling, signal demodulation by transform algebras and decoding.
2. Signal correlation and convolution, interleaving, coding, multiplexing their inverse processes, and others which may be feasible at gigabit rates.
3. Signal processing components, devices, and entire systems.

The objective of this program is to identify feasibility for space-qualified service and to initiate follow-on developmental activity leading to service test hardware.

131. TITLE: Spaceborne Mass Storage Devices

DESCRIPTION: Develop a replacement for mechanical magnetic tape recorders to store large amounts of binary format data in a spaceborne environment. Storage capabilities in the order of  $1.7 \times 10^9$  bits and continuous operations of seven years with high reliability without external maintenance are required. The memory readout should be non-destructive with positive controls to prevent unauthorized alteration of memory content during all phases of operation. The solid state technology used should be hardened to  $2 \times 10$  rads (Si) total dose as a minimum.

Increasing Mean Mission Duration (MDM) and past orbital failures have demonstrated the need for replacement of the currently used mechanical magnetic tape recorders with longer lifetime, higher reliability devices.

Space-qualified mass storage devices with a capacity of  $1.6 \times 10^9$  bits is desired. Ideally, these devices should be interchangeable with magnetic tape recorders on existing space systems.

132. TITLE: Doppler Wind Sensing Lidar and Differential Absorption Lidar (DIAL) Sensors

DESCRIPTION: Spaceborne Lidar sensors have the proven potential of measuring the Doppler frequency shift of radiation backscattered by atmospheric aerosols. Spaceborne DIAL sensors have the potential of measuring temperature and moisture profiles by measuring the intensity of return of radiation emitted near  $O_2$  and

H<sub>2</sub>O absorption lines, respectively. There is also potential for qualified measurement of visibility using Lidar sensors. The goal is to develop sensors for DMSP spacecraft capable of satisfying the validated requirements for wind, temperature, moisture and visibility.

The problem is to develop pulsed laser sources with the necessary lifetime (two to three years at 10 Hz pulse repetition rate), wavelengths, diffraction limited beam, energy (10 Joule), lightweight laser transmitter system, suitable detector system and optimum efficiency to reduce spacecraft power requirements.

Spaceborne active sensors capable of providing required wind, moisture, temperature and pressure data are desired.

133. TITLE: Solid State Device Replacement for Photomultiplier Tubes

DESCRIPTION: The purpose of this effort is to develop a solid state device with a long lifetime (up to seven years) and performance equal or superior to photomultiplier tubes (PMT) in all other areas including cost and the ability to operate under lower illumination than the quarter moon now required of present PMTs. The solid state device will replace PMTs in the DMSP Operational Linescan System (OLS).

The photomultiplier tube currently used in the OLS is especially designed for this application. Long duration life tests have not been possible because of the small number of PMTs available for the OLS. Consequently, present reliability estimates are based on reliability experience with many PMTs not of this particular design. The technology product desired is flight-qualified long lifetime solid state device to replace PMTs in the DMSP OLS.

134. TITLE: Solid State Detector Array Technology

DESCRIPTION: The purpose of this effort is to develop a solid state detector array that operates in at least the visible (0.4 to 1.1 micrometer) and infrared (10.5 to 12.5 micrometer) special regions. The detector should be a 190-310K equivalent black body with a noise equivalent temperature difference of less than .5K with a goal of .1K. Geometric resolution should be 0.3 nmi from 450 nmi altitude over a 112 degree scan angle with a geometric location accuracy of one milliradian. Orbital lifetime should be at least three years with a goal of four years and be able to withstand the orbital environment at 450 nmi.

The current primary sensor of DMSP spacecraft consists of point detectors illuminated by an optical scanning telescope system which is driven in a sinusoidal motion by counter reacting coiled springs and a pulsed motor. A solid state detector array may significantly enhance system reliability and relax current structural and attitude control requirements. Array technology has been principally focused on optical scanning in the visible spectrum rather than a combined visible and infrared. Evolving technology should make a combined system feasible.

Laboratory hardware meeting objectives for integration into the next generation DMSP satellites is desired.

135. TITLE: Advanced Nulling Algorithms

DESCRIPTION: Nulling algorithms presently applied in adaptive nulling systems have not advanced significantly over the years. Advanced algorithms are needed to give nulling antennas under design the capability to deal with the projected increase and more sophisticated threat of interference sources.

Adaptability of the nulling system is needed to accomodate and handle rapid changes in jammer and user characteristics such as frequency, waveform and location.

The advanced algorithm has to be hardware compatible. Consideration should be given to the likely limitations imposed on the algorithm by the hardware.

Upon deriving an advanced adaptive nulling algorithm, a system block diagram has to be derived identifying the hardware building blocks needed. A flow diagram of the algorithm shall be matched to the hardware diagram.

136. TITLE: A Multiple Beam Antenna (MBA) with Feed Clusters for Multiple Limited Area Coverage over Extended Field of View (EFOV)

DESCRIPTION: When limited area coverage zones can be defined which are spread over the EFOV, it is desirable to have a suitable antenna design. Often, a phased array is proposed. However, operational constraints indicate that an MBA is more suitable. Design effort is needed to generate performance parameters for an MBA which provides multiple coverage areas, each only a fraction of the total EFOV.

137. TITLE: Signal Access and Synchronization Technology

DESCRIPTION: When hundreds or thousands of processing relay satellite customers/users wish to gain access into time division multiplex access and frequency division multiplex access channels, it is essential for high quality service that access time and full recognition and frame/bit synchronization be minimized. This means that some automated method is required for fulfilling the processes of call-up, slot reservation, message exchange, exercise of priority, authentication, ARQ, and sign-off.

Most users will operate at 2400 bits per second, while the range may be expected to include 75 bps, 9600 up to 1.344 Mbps and some at video and even at 110 Mbps. Several existing traffic studies in and out of DOD/DCA indicate clearly the mix of customers and message flow so that it is not necessary to reinvest a traffic model, but rather, it is desired that protocols and procedures be established and implemented. When this has been done, it shall be possible to develop message software structures and headers plus hardware implementation on chips such that digital message processing and routing are standardized and expressed in semiconductor-dedicated chip families.

The objective of this task is to define, characterize, and initiate development of signal access hardware, setting the above guidelines.

138. TITLE: Signal Processing Chip Family Definition and Characterization

DESCRIPTION: Contemporary signal processes available for digital signal detection, enhancement of signal-to-noise ratio and error-rate reduction, demodulation and decoding, and addressing and routing, are capable of implementation in solid state technology of a more or less rudimentary character. Major advantages in size and power reduction, and increase in operating speed and sophistication are becoming available in Very High Speed Integrated Circuit and Very Large Scale Integration.

The objective of the procurement is to seek definitions and characterizations of whole families of chips, integrated to provide everything from demodulations to baseband bit streams, including every coding and signal-enhancing technique for interference rejection and processing able to provide digital signal throughput at hundreds of megabits per second in the Wide Band Signal environment to be defined by the Defense Communication Agency for the 1990s and post Defense Satellite Communication System (DSCS) era.

139. TITLE: Switch Matrix Network

DESCRIPTION: Both radio frequency (and intermediate frequency) and baseband multiple input/output switch matrix networks are needed which have good channel tracking, low control power consumption, small time delay, low transmission loss, high directivity and isolation, and high reliability. Present designs and proof of concepts indicate the feasibility of large  $M \times M$  switch networks. Optimum operating frequencies need to be determined consistent and compatible with the switch matrix design concept. A design effort has to be performed aimed at achieving the above mentioned performance characteristics.

A 25 x 25 port switch matrix network should be designed. Key building blocks have to be developed and tested extensively to demonstrate clearly the realizability of a multiple port switch matrix network.

140. TITLE: Low Loss Ferrite Components for Extremely High Frequency (EHF)

DESCRIPTION: Ferrite components play an important role in communication systems. These components are very rugged and usually lower loss than diode controlled devices. However, at EHF, ferrite components development has not progressed due to a lack of need. The existing components are suited only for laboratory use. Ferrite phaseshifters, isolators and circulators have to be developed which are low-loss, small in size, low in weight, and which use minimum drive power. Temperature stability is also important.

141. TITLE: Low Power A/D Converter for Space Systems Application

DESCRIPTION: AFSTC seeks analog to digital A/D converter that operates in close vicinity of cooled focal plane at comparable speed for future space systems application. The resulting system should have similar power consumption to current devices. To satisfy the above criteria, the A/D converter should provide 12 bit resolution to 150KHz sample rate, require about 100MW power, and operate between 10°K to 40°K. Other critical features include linearity, gain and off-set stability over lifetime.

142. TITLE: Development of a Satellite Survivability Methodology

DESCRIPTION: Current military satellites require extensive support from vulnerable fixed ground stations for continued mission performance. The AFSTC seeks to increase space system survivability by automating support functions onboard the satellite (satellite autonomy). In order to implement autonomy in operational satellites, the AFSTC requires a generic methodology that quantifies the effects of increasing levels of autonomy and decreasing levels of ground support versus satellite mission performance and survivability. The methodology can then be used to perform trade-off studies to determine the most effective method of an evolutionary implementation of autonomy for a particular space system. The methodology requires innovative approaches to quantify the complex relationship among autonomy, ground support, mission performance and survivability.

143. TITLE: Space System Test and Evaluation

DESCRIPTION: It is highly desirable to develop a process to integrate test and evaluation considerations when space systems are in the planning stages. Formerly, test and evaluation has been of secondary importance during planning. This study would examine the feasibility of incorporating test and evaluation procedures into the system planning process. The study would examine all phases during a satellite's lifetime design, production, launch, operational readiness and post operation uses. Emphasis would be on the entire satellite, the individual components and the integration of components into the system.

144. TITLE: Space Systems Readiness and Support

DESCRIPTION: Improvement in the readiness and support of current and future space systems is of major concern throughout the DOD. In the past, primary emphasis during development has frequently focused on performance and capability. Of secondary importance was the incorporation of new technologies into logistics and support systems. Additional emphasis on readiness and support will improve the reliability, maintainability, and availability that is possible through innovative technology.

A study should be prepared in order to identify ways of developing technology programs that will help meet the Air Force's goals of improved space system readiness and support. The study would examine the current situation, identify possible solutions and make recommendations on a proposed course of action.

145. TITLE: Turbulence Structuring in High Reynolds Number Flow Fields

DESCRIPTION: Short-wavelength laser propagation from an airborne platform is hampered by optical distortion caused by beam scattering as it passes through the aircraft boundary layer and shear layer flows. This scattering is caused by the small-scale sizes of the turbulence contained in these regions. There is also evidence of large-scale structured turbulence in the flow which is not periodic. Recent work by Dennis Bushnell, et al, of NASA Langley has concentrated on breaking down large-scale structures to small-scale sizes to reduce skin-friction drag. For current purposes, the opposite effect is desired. Innovative

approaches are sought to investigate the feasibility of generating or reinforcing large-scale, periodic structures in a highly turbulent flow field. By producing suitable periodic structures as the dominant feature of the flow field, the possibility of developing adaptive optics to compensate for them is increased.

146. TITLE: Dense Plasma Interaction Study

DESCRIPTION: Technologies developed at the Air Force Weapons Laboratory in the areas of high energy density plasmas, plasma implosion physics, and compact high power electrical energy sources, make possible the production of high energy plasma ensembles which may take the form of high speed plasma jets, or high density selfconfined plasmoids. Starting with a pinched plasma whose number density exceeds atmospheric density by at least an order of magnitude ( $10^{20}/\text{cc}$ ) and whose energy density exceeds several megajoules/cc, jets can be formed whose behavior is dictated by fluid (MHD) constraints and whose speed is expected to exceed 100 kilometers/second. Alternatively by introducing appropriate self-contained currents into the ensemble, an internally consistent, self-supporting configuration of plasma and magnetic fields (a plasmoid) may be achievable. At this time, the technology of formation of such ensembles is more advanced than the understanding of the processes which govern the interaction of such ensembles with their environment. Specifically little is known about the interactions of such ensembles with atmospheric and reduced density air, and only slightly more is known about their interaction with solid density materials. The AFWAL seeks innovative approaches to the study and evaluation of such plasma/air and plasma/solid interactions, including theoretical, analytical and computational approaches to the hydrodynamic and MHD aspects of the problem.

147. TITLE: Gage Development

DESCRIPTION: The Instrumentation Systems Engineering Section of the Civil Engineering Research Division is engaged in making pressure, stress, and acceleration measurements in severe environments. In making these measurements, gage cable survivability is a major concern and cable protection requirements are needed. Such a system should have transducer, memory, power and signal conditioning circuits, and a control device could be either internally or externally triggered. The system must have a data window of 5-100 ms and a sample rate of 10,000 to 500,000 samples per second. The environment of interest would be greater than one KBar and greater than 20,000 g. The system would have control lines for communication with a remote instrumentation van for calibration, T-zero, and other timing signals. Data recovery is intended to be performed by digging up the gages post-test.

148. TITLE: Quantifying Judgment in Survivability Analyses

DESCRIPTION: AFWAL is seeking innovative approaches to the characterization of judgment and technical intuition in the nuclear survivability and vulnerability (S/V) assessment process. Mathematical procedures, such as Fuzzy Set Theory, Ramsey-DeFinetti-Savage Theory, and Bayesian Theory, have possible application in the quantification of subjective elements within current S/V analytic schemes. Techniques developed in the fields of artificial intelligence and image processing

may be adapted to the problem area, which represents the nuclear blast and shock response of protective structural facilities.

149. TITLE: Spatial, Spectral, Time Resolution of X-Ray Bursts

DESCRIPTION: The AFWL is seeking innovative approaches to develop spatially, spectrally, and temporally resolved detection of x-ray bursts. Detection devices should be less than 0.5 meters in maximum dimension and less than 15 kilograms in weight. The spectral range of interest is 50 eV to 5 KeV. The flux range of interest is  $10^9$  to  $10^{13}$  watts isotropic at detection distances of 1 to 3 meters (i.e.,  $10^3$  to  $10^7$  watts/cm<sup>2</sup>). The spectral resolutions of interest are 0.1% to 10%. The time resolutions of interest are 0.5 to 5 nanoseconds. There is special interest in time resolved, space resolved crystal and grazing incidence spectrographs.

150. TITLE: Solid State Power Switching Devices

DESCRIPTION: Solid state power switching devices which can reliably switch electrical currents ranging from 5 milliamperes to 10 amperes are needed for control of special weapons. The devices must also provide minimum circuit isolation in the non-operate (OFF) mode of at least 75K ohms. Volume occupied by the devices must be less than comparable electromechanical relays.

151. TITLE: Laser Window Materials and Designs

DESCRIPTION: High energy laser window materials and design concepts are needed which will allow the transmission of large amounts of laser power with negligible optical distortion. High quality windows are needed for lasers operating at wavelengths of 3600-4200nm, 1315nm, and 300-600nm. Transmission of 99.9 percent is desired. Materials and concepts must be scalable to sizes which allow transmission of megawatts of power with less than 0.05 waves RMS of optical distortion, across the full aperture, at the design wavelength.

152. TITLE: Spatial and Time Resolved Electron Beam Profile Measurements

DESCRIPTION: The AFWL is seeking innovative approaches to nonperturbative measurements of relativistic electron beam profiles. The resolutions of interest are submillimeter to centimeter and subnanosecond to microsecond. What is desired is a means to measure electron density profile in an electron beam/atmosphere interaction for pressures ranging from  $10^{-3}$  atm to 1 atm. Beam parameters are 10 to 100 kiloamps, 1 to 30 MeV, and 0.5 to 2 cm radius.

153. TITLE: Condition of Airport Runways

DESCRIPTION: AFWL is seeking innovative approaches to improving the survivability of the US bomber force and C<sup>3</sup>I aircraft by providing the aircraft with a means of monitoring the condition of civilian airports which may have been under nuclear attack. The monitors must be nuclear survivable and be capable of transmitting information on the usability of the runways to approaching aircraft. Inexpensive techniques are required for sensing runway condition, nuclear and weather environments, and for automatically providing the data to a secure transponder. The monitoring system should also provide to the airport operators



continuing information on runway, environmental and weather related safety conditions during normal operations.

154. TITLE: Space Shuttle Outgassing

DESCRIPTION: Study the production of positively charged ions (of all relevant species) by outgassing, and determine the contribution which they make to the charged particle distribution surrounding the space shuttle orbiter.

The desired product of this research is a report containing a bibliography and review of previous work in this area, formulation of the problems in a mathematical and computational framework, with preliminary results.

155. TITLE: Picture Generation by the DMSP Spaceborne Microwave Radiometer

DESCRIPTION: The Defense Meteorological Satellite Program (DMSP) will be flying a four channel dual polarization microwave radiometer (SSM/I). The SSM/I is designed to estimate atmospheric and geophysical parameters by a numerical inversion technique. A more physical approach would be to generate a series of images from the seven channels (one channel has single polarization). It is possible to generate computer images from the SSM/I data, but since the SSM/I was not designed as an imager, the images may not be true representations because of aliasing. In order to obtain quality images, the antenna transfer function has to be determined. The objective of this research is to investigate the SSM/I antenna transfer function to determine if high resolution pictures can be generated. If so, how could other spectral bands be combined with the microwave pictures to determine atmospheric and surface characteristics.

156. TITLE: RAMAN Detection for Balloonborne Lidar

DESCRIPTION: A balloonborne lidar system is currently in fabrication and is scheduled to begin flight operations in 1984. Balloon flights will be made during nighttime hours at an altitude of about 35 km (115,000 ft.) over desert terrain. The lidar has a neodymium:YAG transmitter with simultaneous outputs at 1064, 532 and 355 nm at power levels of about 200, 140, and 35 millijoules, respectively (2 milliradian divergence). The receiver is a 50 cm Cassegrain telescope with a 4 milliradian field-of-view.

To investigate the feasibility of adding to the present system one or more detectors to observe Raman scattered radiation, in addition to the Rayleigh/Mie, as a technique for determining the concentrations of both major and minor constituents of the atmosphere, e.g.,  $N_2$ ,  $O_2$ ,  $H_2O$ , in the region below the balloon using the basic lidar system described above. Considerations of altitude resolution, integration time and signal-to-noise factors will be addressed in an error analysis appropriate to the use of Raman detection. For the most promising spectral region revealed by this analysis, a Raman detection system will be designed which is compatible with the present lidar.

157. TITLE: Space Correlations of Total Cloud Cover

DESCRIPTION: Using surface observations from about 50 sites selected worldwide, find horizontal correlation functions of total cloud cover. The observations

are given in eighths of cloud cover and the periods of record range from ten to fifteen years. The stations will be grouped into three distinct climatological regions - arctic, mid-latitude, and tropical. Both the product moment and tetrachoric correlations will be calculated for all station pairs in each region for each of the midseason months (January, April, July and October). The correlation values will then be plotted as a function of distance between stations. The plots will be grouped by midseason months and by region for each of the two correlations (product moment and tetrachoric). This will result in 24 plots (4 midseason months x 3 regions x 2 correlations). The resulting correlation functions will be found by analyzing these plots using appropriate nonlinear regression techniques. This will be a 6 month effort culminating in a scientific report.

158. TITLE: High-Current Density Electron Gun for Space Flight

DESCRIPTION: The objective is to design and construct a flight module that will ultimately lead to the construction of an electron gun suitable for rocket, space shuttle and satellite flight. Active experiments are being planned to determine if electron beams can be used to control or mitigate the effects of hazardous or turbulent space environments on Air Force system operations. To maximize testing possibilities for effective controlled use of electron beams, an electron gun with a wide dynamic range in current, energy and current density is needed. The gun should be capable of delivering currents from 100 milliamperes to Amperes with energies to tens of kilovolts. A cathode design must be developed that is capable of meeting these specifications and a module must be designed and constructed that meets the requirements for space flight. The module must be tested and delivered with a report summarizing the module capabilities and including projections on the performance of the complete electron gun.

159. TITLE: Intersatellite Image Comparisons

DESCRIPTION: Meteorological satellites differ from each other in the way image data are obtained. They differ in type of scan, wavelength sensitivity, footprint size and spacing, and response; and it becomes difficult to make quantitative intercomparisons. This effort has the objective to find out directly from image samples ways to circumvent these problems in order to interpret satellite cloud images correctly. By "directly" is meant the actual comparison of data and the development of schemes to make one source of data comparable, for operational systems, to another. In terms of the footprint and possibly the wavelength band, LANDSAT could be made to look like one of the meteorological satellites, but not vice versa. Wavelengths of prime interest are the visible and the far infrared. Physical calibrations and factors contributing to differences should be studied. The goal is to develop ways to make data from one satellite comparable to another for purposes of correctly interpreting the data from various systems. Initially, the investigation should use observations which are near the subpoint of the satellite in order to avoid the complicating factors of interpreting data at large scan angles. The satellite observations of major interest are from GOES, the Air Force DMSP, NOAA polar orbiting satellites, and from LANDSAT. Data comparisons desired are GOES to DMSP, NOAA to DMSP, LANDSAT to DMSP, and LANDSAT to GOES.

160. TITLE: Carbon-Carbon (C-C) Material Property Sensitivity

DESCRIPTION: Service failures of solid rocket nozzle components demonstrate their performance is sensitive to material property variations that have not been adequately characterized. As the density of a 2-D carbon-carbon exit cone increases, the strength and stiffness increase, but in an undetermined proportion. When the stiffness increases, thermal stresses usually increase and this rise in stress could exceed strength improvements. The net effect in this case would be to increase the risk of failure. Critical elevated temperature compression properties are also sensitive to processing and designers must know all first order property sensitivities and their impact on thermostructural behavior in order to set acceptance criteria for fabrication.

The objective of this program will be to identify critical material properties for the thermostructural behavior of solid rocket nozzles in a service environment; to characterize experimentally the sensitivity of these properties to process and raw material variations about a baseline material system now in use; to develop process-property relationships in graphic form and show historical data; to prepare engineering design guides for nozzle designers and composite fabricators for structural carbon-carbon materials.

161. TITLE: Rocket Nozzle Computer Code Sensitivity Analysis

DESCRIPTION: Three computer programs are being used at AFRPL for liquid rocket nozzle analysis. These include: The Solid Performance Program (SPP), the Two Dimensional Kinetics Program (TDK), and the Boundary Layer Integral Matrix Procedure (BLIMP). Three in-house projects will experimentally measure nozzle performance of several engines using  $N_2H_4$ , MMH, or  $H_2/O_2$  as propellants, in order to validate the predictive capabilities of these programs. An analysis shall be performed to determine the sensitivity of vacuum specific impulse (Isp) prediction to variation of input parameters, and to allow selection of boundary layer parameters to be measured experimentally to validate the computer codes.

The objective of this work shall give AFRPL a comprehensive understanding of how the computer input parameters affect prediction of vacuum specific impulse, and shall determine which boundary layer parameters will be measured for validation of the computer programs. Effects of chamber pressure, chamber and nozzle geometry, and mixture ratio shall be considered.

162. TITLE: Carbon-Carbon Exit Cone Billet Engineering Design

DESCRIPTION: The design of carbon-carbon exit cone billets for solid rocket nozzles for even the most common constructions, materials and process cycles continues to be the source of serious hardware problems. Progress is being made in isolating and solving raw material problems, in-process material response problems and facility dependent problems.

The objective of this program will be to provide for the design process of the advanced modeling tools developed for material architecture, for material response and for predicting the processing environment. A second objective, and one which must occur in parallel with the first, is to assemble the available

in process material characterization data and make it available to the billet designer in a form readily usable by the new modeling tools.

The modeling tools to be developed include the following:

- Display billet, net part, ply pattern, and interleaf geometries;
- Output data for fabrication lay-up and perform tooling;
- Output material rotation angles throughout the billet, and net-part for computer structural analysis;
- Quantity fabric distribution;
- Permit design or redesign based on architectural constraints;
- And generate billet or net-part geometries given the ply pattern.

163. TITLE: Particle Infrared (IR) Optical Property Measurement Technique Definition and Design

DESCRIPTION: Accurate prediction of missile IR signatures with state of the art computer codes (e.g., the JANNAF SRRM Code) is limited by--and highly sensitive to--uncertainties in IR optical properties. An accurate quantification of these will significantly improve plume radiation predictions since accurate data is not available, and some species, most notable  $Al_2O_3$ , are susceptible to large property changes under the contaminated conditions of rocket plumes.

The objective is to define techniques and procedures to be used to determine the particle index of refraction and emissivity. The measurement system design and total parameter estimation error budget shall be generated, and the impact of particle density and shape on the measurement error of the designed system shall be included. The design shall be capable of determining the complex index of refraction and emissivity of particulates at a minimum of eight temperature steps, with the steps at or near 300K, 500K, 1000K, 2000K, melting temperature plus 100K and 2500K. The design shall also be capable of determining the optical parameters at a minimum of five spectral regions at or near 0.3-, 0.6-, 1.2-, 3-, and 10-microns. Any other specification suggestions will be welcome.

The design will be such that captured, purposefully contaminated or pure form  $Al_2O_3$ ,  $ZrO_2$ , C, ZrC and MgO particles in the submicron and several micron size ranges can have their IR optical properties determined. Finally, an important driving constraint in the measurement technique definition is that the chemical composition and particle morphology must remain unchanged; any alteration of these could significantly change the properties of the already contaminated particles.

164. TITLE: Composite Material Bond Agent Investigation

DESCRIPTION: Recent investigations in solid rocket nozzle development has discovered a lack of property data concerning structural adhesives. This data is required for the design and analysis of nozzle components. This study would create a baseline characterization of the most commonly used bonding agents and adhesives in solid rocket nozzles. The critical analysis and design properties of resins, epoxys, and polyamides should be addressed. The characterization

would need to be accomplished at both room temperature and elevated temperatures simulating a motor firing. Various properties, such as the amount of bonding achieved, the effects of fillers and cure methods, property degradation, strengths, strain, creep, conductivity, char yield, and thermal expansion would be investigated and related to their temperature dependency.

165. TITLE: Particle Contamination Technique Definition and Design

DESCRIPTION: Accurate prediction of missile IR signatures with state of the art computer codes (e.g., the JANNAF SIRR code) is limited by--and highly sensitive to--uncertainties in IR optical properties to much greater accuracy than the order of magnitude discrepancy that may exist with current data. The present error may arise because some species, most notably  $Al_2O_3$ , are susceptible to large property changes under the contaminated conditions of rocket plumes.

The objective is to define techniques and procedures to contaminate commercially pure samples of  $Al_2O_3$ ,  $ZrO_2$ , C, ZrC and MgO particles in the submicron and several micron size ranges to resemble particles captured from rocket exhaust plumes. The particle contamination system design must be capable of matching rocket exhaust particles to base material, contaminant and surface morphology at temperatures ranging from 100K to 2500K and at least five spectral regions at or near 0.3, 0.6-, 1.2-, 3- and 10-microns. The total error budget for the particle contamination system design will also be generated. Any system design must not introduce changes to the chemical composition or particle morphology to either rocket exhaust or artificially contaminated particles.

166. TITLE: Phase Shifters for Phased Arrays

DESCRIPTION: Ferrite phase shifters are a major factor in the development and acquisition of phased array radars. They are lossy and expensive; sources of supply are very limited. Other alternatives may either lack the power-handling capability of ferrite phase shifters or suffer greater losses. Alternatives to current 4-bit and 6-bit ferrite phase shifters with respect to performance (insertion loss and peak power handling capacity) and cost (phase shifter and driver) are sought.

167. TITLE: Routing Algorithms for Networks Comprising of Heterogeneous Link Capacities

DESCRIPTION: Packet networks deployed in a tactical environment will have to contend with individual links that provide many different transmission rates or capacities. These can range from 2.4 kb's to as high as MB's as an example. Current routing techniques do not directly consider individual link capacities in the route selection although they can have considerable effect on the system throughput. The key to good throughput is to be able to determine the best routing strategy in a situation where the overall traffic and the varying link capacities all impact on a selected route. The purpose of the proposed effort will be to develop and document specific routing algorithms.

168. TITLE: Improved Microwave Signal Control Components for Phased Array Antennas

DESCRIPTION: Wideband phased arrays for military applications require non-dispersive time delay units and phase shifters which operate efficiently in the microwave frequency bands. Variable time delays up to 30 nanoseconds are required with a resolution on the order of 1 per carrier frequency of the radar. Instantaneous bandwidths of 10 percent of the carrier frequency are necessary in devices with significantly less loss than found in current acoustic and switched line devices. Phase shifters with resolution equivalent to eight bits are required to carry up to 50 watts of peak power with insertion losses less than 1 dB. It is desirable that these devices be in a form which permits integration into monolithic microwave circuitry as the cost and losses of current production devices make them unsuitable for many array applications. Research into new approaches to achieving these devices is encouraged.

169. TITLE: Multi-Wavelength Narrow Band Sources

DESCRIPTION: To increase utilization of fiber optic communication links it is desirable to multiplex signals, with the greatest advantage gained by using multiple wavelengths. Minimum attenuation and dispersion occurs in the neighborhood of 1300 nm and thus multiple sources are needed in this wavelength range. Several efforts utilize a variety of dispersive mechanisms (eg, the effort under RADC sponsorship to develop a 10 to 12 wavelength multiplexor using grating dispersion.) This approach requires a separate stable and pre-determined wavelength source for each channel. At present these sources are injection laser diodes which are expensive, fragile and require external temperature stabilization.

We are seeking methods to generate multiple narrow band signals, separated by approximately 15 nm from a smaller number of sources. One approach could be use of a variable wavelength source to generate several wavelengths for external modulation. A recent effort in this area has been the development by Bell Laboratories of the cleaved coupled cavity laser which has shown up to 10 different lines spaced 10 angstroms apart, which can be pulsed rapidly from one line to another. Another method to be considered is the optical equivalent of mixing to generate multiple wavelengths. This could be accomplished in theory by the use of a non-linear medium to generate multiple wavelengths from the interaction of two independent light sources. Other approaches should be examined.

The resultant wavelength spectra would then be externally modulated by independent signals to generate the wavelength division multiplexed output.

170. TITLE: Active Modulator Compensation Techniques

DESCRIPTION: Signal fidelity requirements in high performance tactical and strategic surveillance systems put stringent voltage specifications on the final amplifier power supply. Previously, modulator/power supply pushing factors were minimized via the construction of "stiffer" power supplies. The size/weight constraints of "state-of-the-art" systems precludes such an approach. Alternative methods of maintaining amplifier signal fidelity in the ground and

airborne environment must be developed which will minimize size and weight maintaining performance commensurate with 50 to 60 db MTI cancellation ratios and high reliability and maintainability.

171. TITLE: Compositions for Radiation Hard Doped Core Optical Fibers

DESCRIPTION: Optical fibers are being incorporated into the designs of many new C3I weapons systems designs because of their EMP/EMI immunity and other advantageous properties. All presently available optical fibers that can meet mechanical and thermal systems requirements have silica-based compositions. Except for systems utilizing less than a few hundred meters of fiber, graded-index optical fibers must be used to meet bandwidth requirements. The graded-index is achieved by doping the fibers' silica cores with index-modifying elements. All of these fibers show significant permanent and transient increases in loss of transmission when exposed to nuclear radiation and consequently are not compatible with many systems nuclear vulnerability requirements. A program for the development of new, or modifications of present, compositions for doped-silica core optical fibers that will be more radiation resistant is, therefore, needed. Optical fibers fabricated on the basis of possible improved core compositions should be provided for tests of their radiation vulnerability.

172. TITLE: Submicrosecond Fiber Optic Switches

DESCRIPTION: Modern fiber optic communications networks require electro-optical switching components for optical signal routing. Local area networks in particular require a series of 2 x 2 optical bypass switches to maintain network continuity if a local terminal fails. Generally, the usefulness of optical switching components depends upon their insertion loss and switching speed. Present-day components, including electro-mechanical switches are deficient in speed. The millisecond response times have limited the applications areas of those devices. Research is needed to demonstrate the feasibility of new classes of fiber optical switches.

Ferroelectric liquid crystals offer the promise of an improvement in switching speed by more than three orders of magnitude, with an on/off cycle requiring less than one microsecond in principle. Bistable switching is also possible in theory. Bistability represents another improvement because no power is required to sustain either state.

If feasibility can be shown, the results will apply also to waveguide switching in integrated-optics applications.

173. TITLE: Intelligent Noise Stripping for Speech Enhancement

DESCRIPTION: Existing noise stripping algorithms for voice communications channels do not take advantage of knowledge of the communications vocabulary for speech enhancement. In many communications environments, limited vocabularies are the rule rather than the exception. Such information can be used in a machine "expert" fashion to apply inference rules regarding the intended message. Application of such knowledge source can be used to improve the intelligibility and information content of the message following the noise stripping process. This effort will provide an analysis and a suggested design for an expert system

approach to using lexical and syntactical knowledge and inferences to improve speech enhancement algorithms.

174. TITLE: Modulated High-Current Electron Gun

DESCRIPTION: Recent advances in the development of electron guns suggest that it may be feasible to exploit their use in the ionosphere for the generation of ELF/VLF/LF radiowaves. Such use requires the development of a gun capable of producing high current (tens of amperes) which is rugged, of light weight and small enough to be suitable for operation on a rocket or space shuttle. The gun should produce electrons with variable energies extending into the kilovolt range and be capable of being modulated from 0 to at least 100kHz. The cathode configuration is most crucial to the development of an electron gun suitable for use in space. The power supply required for the cathode operation will largely decide the size and weight of the gun module and is dependent upon the efficiency of the cathode. The objective of this research is to develop a cathode which minimizes the heating power required per ampere of beam current, is of sturdy construction to withstand rocket flight, does not deteriorate during exposure to atmospheric gases while cold and produces at least tens of amperes current with electron energies up to at least tens of kilovolts while being capable of modulation from 0 to at least 100kHz.

175. TITLE: Radio Electronic Combat Vulnerability Analysis (RVAN)

DESCRIPTION: Conduct analysis of selected developmental system designs to identify weaknesses which are potentially exploitable by an enemy. The analysis should consider the impact of existing and projected radio electronic combat threats on system performance in an operational environment. It should also identify the characteristics of future capabilities which would allow an enemy to exploit the system.

176. TITLE: Direction Finding (DF) Cut-to-Cut Correlation

DESCRIPTION: A key task required for several command, control and communications (C<sup>3</sup>) countermeasures is emitter location by direction finding (DF) and triangulation. To have the requisite location accuracy, the base line has to be relatively long and several direction observations (cuts) may be required. For many signals a number of emitters will probably be operating on the same frequency and the duration of any particular emission will be relatively short. Thus, if a single DF platform is used, it will be necessary to correlate an emission received at one time with later emissions. If multiple platforms are used, one has to correlate emissions between them.

Specific emitter identification and fingerprinting are two of the terms applied to the capability to tag a particular emitter so that its emissions can be correlated. The term fingerprinting will be used in the widest sense as any emitter tag that can be used for correlation. Areas of interest for a given set of signals are: (1) Which ones can be fingerprinted by existing systems? (2) What is the signal-to-noise ratio? (3) What is the dwell time? (4) What other reception requirements are important? (5) What are the associated error probabilities as a function of the signal environment? (6) Are the techniques applicable in a wartime environment? (7) What are performance expectations? (8) Are there promising approaches that are



being neglected? This task would develop and document fingerprinting and identification techniques that resolve the above issues, in particular for cut-to-cut correlation.

177. TITLE: Remote Communications Antennas

DESCRIPTION: Investigate feasibility of providing remote antenna and/or transmitter subsystem capability for critical ground communications terminals, e.g., for JTIDS or GMF satellite terminals, as an anti-ARM or anti-location protection measure for the main terminal and operating personnel. Select a candidate system and determine the modifications (signal format, etc.) necessary to accommodate remoting.

178. TITLE: Adaptive Beam Communication Antennas

DESCRIPTION: Investigate the feasibility and desirability of using self-aligning beam array antennas for communications to reduce the probability of intercept outside the main beam and improve jam resistance by increasing the effective radiated power. Determine appropriate array configuration as a function of frequency from VHF through millimeter waves. Determine appropriate codes for synchronization beam-forming signal. Such a system could eliminate the acquisition delay associated with narrow-beam systems. This technique is differentiated from numerous jammer nulling phased array system, although a nulling subsystem could be combined with the beam forming subsystem.

179. TITLE: Cover, Concealment, and Deception (CC&D) Penetration

DESCRIPTION: Many enemy targets, especially command, control and communications (C<sup>3</sup>) targets, will make maximum use of cover, concealment and deception (CC&D). Additionally, most weapon systems require imagery evidence of a target before they are tasked. Synthetic aperture radar (SAR) systems provide an attractive source of such imagery, since they can operate from standoff positions and are relatively unaffected by weather. The capability of SAR to find enemy C<sup>3</sup> targets under various conditions of CC&D should be analyzed. In addition to an assessment of SAR performance against obscured (or partially obscured) targets, the analysis should address the added value of using a prior knowledge, change detection schemes, and/or higher resolution.

180. TITLE: Forward Air Controller (FAC) Jammer Study

DESCRIPTION: The communications between an enemy Forward Air Controller (FAC) and the aircraft it controls is a lucrative target for jamming. An analysis is needed to determine the type of jamming system that would be most effective against the FAC communications while remaining the least vulnerable to enemy counteractions. Issues of mobility versus vulnerability; airborne versus ground-based options; operational concepts; jammer command, control and communications (C<sup>3</sup>); and required coordination with friendly forces should be explored.

181. TITLE: Use of Surface Acoustic Wave Devices for Electronic Counter-measures Analysis

DESCRIPTION: Surface acoustic wave (SAW) technology has produced small, highly reliable devices which may be used to detect the presence of ECM, chaff, and ground clutter in received radar signals. This technique may have broad application to threat simulators on electronic warfare test and training ranges. First, the research should review existing threat simulator hardware and determine if the device may be practically adapted to both emitter/receivers and emitter-only type systems. Second, the research should review the SAW device capability to isolate chaff, noise jamming, and deceptive ECM techniques from the received signal. Third, the research should propose hardware and software approaches to process and quantify the detected chaff and ECM.

The report of this research will be used as a basis for enhancing existing training range capabilities and could have far reaching application in reducing the cost of future training range threat simulators.

182. TITLE: Generalized Nonnuclear Munitions and Armaments Research

DESCRIPTION: New and improved ideas/concepts and analysis methodologies are desired in the area of nonnuclear munitions and armaments. These include chemical and fuel-air explosives, energy sources and conversions, bombs, submunitions, warheads, fuzes, dispensers, guns, rockets, ammunition, ammunition feed systems, mines, sensors and seekers, explosives, propellents, carriage and release equipment, aerodynamic and structural technologies, tactical missile guidance and control technologies, exterior ballistic analysis, lethality and vulnerability assessment techniques, and chemical warfare technology. Some examples of desired research are low drag/observable weapon airframes, conformal ejector racks, integrated fuzing, millimeter wave seekers/sensors for midcourse and terminal guidance, heavy metal self-forging fragments, heavy metal shaped charges, long rod penetrators, reactive fragment warhead, and computational fluid dynamics.

183. TITLE: Gallium Arsenide Solid State Accelerometer (GASSA)

DESCRIPTION: Acceleration/deceleration is always present during the launch and/or terminal engagement of air-launched weapons. Various devices, mainly mechanical, have been utilized to provide inputs to safe and arm subsystems and fuzing logic for safe separation and/or detonation decisions. Due to the low sensitivity and poor accuracy of existing economical devices these fuzing decisions have of necessity been gross, limiting effectiveness parameters such as launch envelope and warhead detonation point. Previous development programs on the silicon solid state accelerometers have demonstrated the technology necessary to batch fabricate single chip accelerometers in the range from .01g to 100,000g with sensitivity versus natural frequency equal to or better than commercially available discretely fabricated accelerometers in the \$100 to \$300 price range. Although considerable progress has been made, the desired level of accelerometer sensitivity has not been achieved. Recent advancements in the use of gallium arsenide devices suggest that this technology has the potential of a sensitivity factor improvement of 5 to 20 over that of silicon.

The objective of this program will be to investigate the potential of gallium arsenide accelerometers to improve sensitivity levels. This program will concentrate on improvement in areas to include: temperature stability, yield, packaging for environmental survivability, reliability, and ease of interfacing with decision logic circuit. One of the main efforts will involve placement of all temperature compensation and amplifier circuitry on the accelerometer die instead of on a separate substrate as in the earlier development program.

184. TITLE: Development of an Energetic Polymer/Plasticizer for Plastic Bonded Explosives

DESCRIPTION: Currently, plastic bonded explosive formulations utilize an inert binder system which comprises 15-20% by weight of the system. This inert material contributes no energy to the system and dilutes (separates the crystals) the explosive system resulting in uneven energy being imparted to special warheads, such as shaped charge and long stand-off penetrator items, where smooth detonation front and high energy are critical for performance.

These systems could possess several merits: reduce the amount of costly and critical HMX required; enable the substitution of RDX for HMX (resulting in increased energy), increase the performance in special warhead technology, and improve safety characteristics.

The necessary effort could be a study to assess the feasibility of producing energetic polymer/plasticizers and to do formulations. If analyses and tests show the approach has promise, then a series of loaded test hardware should be tested to select the best candidates to continue work toward greater performance and improved processing.

185. TITLE: Development of High Voltage Transformers for Electronic Fuzes

DESCRIPTION: Electronic bomb fuzes are under development which employ high energy electrical firing circuits to initiate the explosive train as opposed to conventional detonators. These high energy circuits require small, high efficiency, high reliability transformers to convert supply voltages of 20-30 volts to 2-2.5 kilovolts for storage on capacitors. In order to maintain the highest level of safety, it is necessary to completely isolate the high voltage circuits or restrict the generation of high voltage to a unique set of environmental circumstances. To this end the transformer must possess inherent in its design or through dedicated circuitry the ability to function as a "decision-making" device and a fail safe high energy barrier.

This effort could be divided into two phases. Phase I would investigate several approaches to the problem and result in a number of candidate designs. Phase I would not be restricted to a particular type of transformer or a particular technique though the following should be included: (1) Approaches to tuning the transformer to the alternating current output of an environmental power supply. (2) Approaches to generating the high voltages across a continuous metal barrier, conceived as a can which contains all the high voltage circuits. (3) Unconventional transformers such as piezoelectric transformers and others should be addressed along with conventional devices.

Phase II would entail the fabrication of a small number of examples of the most promising design(s) for evaluation and possible integration with prototype fuzes.

186. TITLE: X-Ray Smear Camera

DESCRIPTION: Optical smear cameras utilize a slit and rotating mirror to sample events propagating in one direction in space as a function of time. Optics limits one to surface observation of detonation phenomena for opaque explosives whereas an x-ray system given sufficient energy resolution and dosage would permit interior study of detonation phenomena. An analytic study to determine the feasibility and to develop a preliminary design for an x-ray smear camera is needed as the first phase.

187. TITLE: Development of External Aid for Rapid Transfer/Alignment

DESCRIPTION: One of the problems with inertially-guided tactical weapons is that of rapid transfer/alignment. Vector-matching between the master (aircraft) and slave (missile) inertial system typically requires up to five minutes to achieve an accurate transfer/alignment. During this time the aircraft must perform several maneuvers in order to excite the proper state variables so that discrepancies may be observed. A major contributor to the complexity of this problem is the fact that the slave system is on the aircraft's wing and, therefore, undergoes motion due to the wing's dynamic flexure.

An approach which needs to be investigated is the development of an external aid which could provide an almost instantaneous transfer/alignment (e.g., an optical scope). Such an aid would be hard-fixed to the aircraft fuselage and would have the capability to observe the attitude (and possibly the time-rate of change of attitude) on the store. This observation could then be fed into a one-step Kalman filter. Innovative ideas are sought and various technologies should be considered.

The necessary effort could be divided into two phases. Phase I would be a study to assess the feasibility of the approach, preferably with a co-variance analysis. If Phase I shows the approach has promise, then Phase II would involve testing the unit to confirm its level of performance.

188. TITLE: Barrel Materials for Electromagnetic Rail Guns

DESCRIPTION: Electromagnetic rail guns are being developed to fire projectiles of several grams at velocities of several kilometers per second. The barrels of these rail guns are composed of two narrow conducting rails extending the full length of the barrel and separated by insulating rails to form the bore. Currents on the order of a million amperes flow down one conducting rail, through an armature at the rear of the projectiles, and back through the other conducting rail to the source. The armature may be either a solid conductor or a plasma.

Research and development is needed to find a candidate material for both the conducting and insulating rails. Several rail guns have been constructed that use copper alloys for conducting rails and fiberglass composites for

insulating rails. Neither material is satisfactory because the barrel environment erodes the rails. Heat and pressure cause surface melting and ablation of the materials. The damage mechanisms should be defined (i.e., friction, ohmic heating, hot gas cutting) and material characteristics established to resist these mechanisms. These material characteristics must include the conductivity required by the conducting rails, and the resistivity required by the insulating rails. Using the material characteristics, candidate materials for both conducting and insulating rails can be proposed. These materials might be metals, alloys, ceramics, composites, or advanced formulations.

189. TITLE: Digital Mission Management System for Advanced Dispenser Weapons

DESCRIPTION: The next generation of submunition dispensing weapons will be very sophisticated. They will be blended-body, conformally-carried configurations that will be powered with pulsed motors, and require for some targets both midcourse and terminal guidance. Additionally, the advent of smart submunitions will require the capability to precisely coordinate target sensing and submunition dispense events. Sequential dispensing from multiple submunition bays will be required for some target and submunition combinations. Further, since some targets (e.g., airfield runways and armor columns) require a dispensing vehicle to geometrically match its submunition dispensing pattern with that of a specific real time target orientation, a highly capable digital mission management system is required for next generation advanced dispenser vehicles. The objective of Phase I of this program would be to define a system architecture for a digital mission management system for an advanced dispenser weapon, which would have the following capabilities as a minimum:

- a. Be compatible with a MIL-STD-1760 aircraft stores management system.
- b. Perform initialization functions for guidance systems (midcourse and terminal).
- c. Perform propulsion management (energy management) functions.
- d. Perform submunition fuze setting functions.
- e. Coordinate submunition (or subpack) ejection events with target sensing data.

Phase I would also produce a detailed program plan for follow-on Phase II work. Phase II of the program would involve fabricating a bread board simulation of the digital mission management system and conducting system verification tests.

190. TITLE: Development of Inertial Navigation Unit for Tactical Weapons

DESCRIPTION: Inertial navigation is an attractive alternative to tactical weapon guidance because it is completely autonomous and cannot be jammed. The problem with the use of inertial guidance is high cost associated with sufficiently accurate systems. One approach which should be investigated is the use of newly developed low cost inertial instruments (gyros and accelerometers) in a gimballed platform system. In a gimballed platform the low cost instruments would be subject to a more benign environment than they encounter in present strapdown systems. The platform environment would increase sensor accuracy and reduce computational requirements but increase mechanical complexity. A systems

approach is necessary to determine the cost effective approach.

The necessary effort could be divided into two phases. Phase one would be a study to assess the feasibility of this approach. If phase one shows the approach has promise, then phase two would be the construction of a unit which would be tested to determine the level of performance which could be achieved.

191. TITLE: Investigate Fluid Flow Phenomena to Improve the Performance of Flight Vehicles

DESCRIPTION: This project supports research in external aerodynamics, turbulent and unsteady flows, and internal fluid dynamics. The objective is to investigate the fluid flow phenomena that strongly influence the aerodynamic performance and efficiency of current and future flight vehicles, to understand the structure of turbulence in shear flows, and to improve our understanding of and capability to predict three-dimensional flow past geometrically complicated configurations. We are interested in methods for automatically generating solution-adaptive computational grids; exploiting the unsteady flow characteristics that will improve aerodynamic efficiency and enhance performance; improving experimental and theoretical modeling capability for deflected engine exhaust jets that may interact with solid surface and encounter cross flows; numerically simulating time-evolving turbulence features; passively, actively, and interactively controlling turbulence characteristics; numerically computing on- and off-design flows in low aspect ratio and high pressure ratio compressor blade passages. Proposals should be in one or more of the following areas: Effects of viscosity, turbulence, pressure and temperature gradients, compressibility, and nonsteadiness of flows; interactions of the shock wave-turbulent boundary layer for a range of Mach numbers; severe separation from wings and wing and body configurations; turbulent structures and their interactions in free and bounded shear layers; the behavior of attached and separated unsteady shear layers affected by time-dependent boundary conditions; generic characteristics of driven, unsteady separated flows; flows in internal passages in lasers; compression system instability; dynamic stall on two and three dimensional lifting surfaces; aerodynamically forced response of stator blades; and effective active cooling for turbine blades.

192. TITLE: Improve the Long-Term Durability and Reliability of Aerospace Structural Systems

DESCRIPTION: This project supports research in structural mechanics, structural durability, and civil engineering. The objective is to explore the behavior of aerospace structural systems in a variety of environments, the long term durability and reliability of those structures, and the properties and behavior of new materials to be used for strategic and tactical structures. We are interested in developing structural response models, models for predicting damage growth and structural life, and constitutive models for geotechnical and construction materials; studying the strength and fracture characteristics of brittle materials; investigating explosion-induced soil liquefaction; and developing, identifying, and measuring in situ soil properties. Proposals should be in one or more of the following areas: The role of internal and external nonlinearities of structures; ways in which to control the behavior of the

structures; interactions between flexible aerospace systems and their on-board controllers; ways in which fatigue and fracture damage structures, especially composite structures; new materials or approaches that will lead to the survivability of strategic structures in a nuclear weapons environment, the survivability of strategic and tactical structures in a conventional weapons environment, and rapid repair of tactical and logistical aircraft launch and recovery surfaces.

193. TITLE: Enhance the Performance of Flight Vehicles by Improving Air Breathing and Rocket Combustion and Plasma Energetics

DESCRIPTION: This project supports research in airbreathing combustion, diagnostics in reacting media, rocket combustion dynamics, and plasma energetics. The objective is to study the physical and chemical processes of combustion in an airbreathing propulsion system; develop techniques for sensing temperatures, concentrations, and velocities in energy conversion systems; understand combustion and reacting flow processes; and study advanced space propulsion. We are interested in models of turbulent fluid transport processes, photochemical and catalytic methods for more stable ignition and enhanced combustion of present fuels and future alternatives, noninvasive sensing and diagnostic techniques and strategies, methods for analyzing the stress of nonlinear viscoelastic materials, thermal protection techniques for isolating plasma from inert components, and noninterference techniques for measuring plasmas. Proposals should be in one or more of the following areas: Fluid transport processes; stable ignition and enhanced combustion of present and future fuels, control of the rate of combustion, and reduction of undesirable combustion products; the combustion of liquid fuel and high energy slurry fuels; reacting flows in the hostile environments of high performance systems; combustion instability problems in solid and liquid rocket systems; instability phenomena that degrade the performance of ramjet combustors; role of advanced energetic ingredients in solid propellant burning; state of combustion products in plumes; thermodynamic, kinetic, and transport properties of pure substances used for propellants; sources of physical (nonchemical) energy, such as electrically conductive flowing gases or plasmas; the mechanism of release of that energy; and the devices for converting that energy; the phenomena of energy coupling and transfer of energy flows in electrode and electrodeless concepts under plasmadynamic environments and conditions that orbiting plasmadynamic systems encounter; pulsed and steady-state equilibrium and nonequilibrium flowing plasma; characteristics of electrical and hydrodynamic flows; instabilities of plasma bulk and wall layers; interactions of plasma-surface, -electrode, -magnetic, and -electric fields; energy losses to inert parts; plasmas generated at high magnetic fields and pressures; and characteristics of advanced refractory materials exposed to working fluids and life-limiting mechanisms.

194. TITLE: Innovative Research to Understand the Physical Processes of the Atmosphere

DESCRIPTION: We are seeking proposals for basic research in the following areas: Mesoscale dynamics, including the use of ST-type radar; planetary boundary layer coupling to the mean flow, size, and composition of atmospheric aerosol; aircraft icing; lightning; electromagnetic signal propagation (visible, Infrared,

millimeter wave, etc.); ionospheric-thermospheric coupling; and ionospheric processes that affect communications and surveillance systems.

195. TITLE: Develop New and Improved Analytical Instrumentation and Advanced Concepts in Structural Polymers and Ceramics

DESCRIPTION: This topic includes five principal subareas: chemical techniques, structural chemistry, surface chemistry, molecular dynamics, and chemical reactivity and synthesis. Research in chemical techniques focuses on developing new and improved analytical instrumentation and methods in electrochemistry and detection (specifically the nature of electrodes and electrochemical reactions). Research in structural chemistry encompasses programs in polymer science, glass, and advanced structural ceramics and ceramic composites. Research in surface chemistry investigates gas and solid surface interactions, surface characterization, surface reaction kinetics and mechanisms, the characterization of thin films, the interaction and reactivity of gases with thin films, the stability of substrate and thin film interfaces, film nucleation and growth, and interactions of intense light and thin films. Research in molecular dynamics examines well-defined microscopic molecular systems in reactive and nonreactive molecular collisions by using selected energy states of reactants and analyzing the energy through available molecular energy levels or through emission of radiation. Research in chemical reactivity and synthesis seeks to explore new and better methods for characterizing and synthesizing new organic, inorganic, organometallic, and organometalloid compounds (particularly organosilicon and fluorocarbon substances), and novel approaches for making reaction intermediates that can be used to tailor chemical structures with desirable properties.

196. TITLE: Improvement in the Technology of Monolithic Microwave and Millimeter Wave Integrated Circuits

DESCRIPTION: This project includes 3 topics: monolithic microwave and millimeter wave integrated circuits, superconducting analog signal processing, and process modeling for compound semiconductor technology. The research in monolithic microwave and millimeter wave integrated circuits seeks to identify improvements in materials, processing techniques that can be automated, and device designs. Monolithic refers to the fabrication on a single semiconductor chip of active and passive components, such as transistors, capacitors, inductors, and interconnections. Needed research includes work on substrates, active layers, device modeling, millimeter wave device designs, and monolithic integration. Implementation will be in gallium arsenide or indium phosphide or related ternary compounds at frequencies up to 100 GHz.

One promising approach for future signal processing applications is the use of circuits based on superconducting analog elements. The basic functional needs for high speed, wide bandwidth signal processing are delay (compact structure), tapping (accurate), multiplication (dynamic range), and summation (phase coherence). Candidate research topics include more reproducible and uniform tunnel oxides; discrete devices, such as convolvers and correlators; more complex circuitry, such as programmable matched filters and time-integrating correlators; a combination of superconducting and cooled-semiconductor devices; and photo-introduction of signals into the cryostat to avoid wires.



Silicon device and integrated circuit technologies have been greatly fostered by the availability of computer simulation tools, such as SUPREM and SPICE. Under the topic of process modeling for compound semiconductor technology, we are seeking suitable process models for compound semiconductor materials, such as gallium arsenide and indium phosphide. We are interested in research that proposes models for bulk materials processing, such as liquid encapsulated Czochralski (LEC) and horizontal or vertical Bridgman. Other areas of interest include device and/or integrated circuit models that incorporate the standard fabrication steps, including implantation, thermal annealing, dielectric formation, metalization, etc.

197. TITLE: Development of Novel Thin Film Deposition Techniques

DESCRIPTION: This project includes research in novel thin film deposition techniques. Currently, Air Force optical systems are limited in performance by thin film properties. Existing deposition techniques, such as thermal evaporation and sputtering, result in films with a microstructure described by the structure zone model. Thin film performance could be improved with deposition techniques, such as energetically enhanced chemical vapor deposition, molecular beam epitaxy, ionized cluster beam deposition, or other ultrahigh vacuum epitaxial techniques, that permit more control over film morphologies. The ultimate goal of investigating these techniques is to find a technique for the deposition of a perfectly amorphous or a perfectly single crystal optical film that has thin film properties approaching those of the bulk material. We are interested in research that proposes to characterize novel deposition techniques or to model growth and deposition phenomena.

198. TITLE: Research in Neuroscience, Psychophysiology, and Toxicology

DESCRIPTION: This project includes research in bioreactivity, bioenvironmental hazards, biocybernetics and workload, and information processing. Physiological characteristics determine how well people work in demanding environments. Human-machine systems that are not well matched to human physiological characteristics cannot operate optimally. In an effort to explain the links between physiological characteristics and human performance, the research in bioreactivity examines the mechanisms that control neuronal activity. The current focus is on neuronal regulation and adaptation, including control of neurotransmitter release and postsynaptic response, activation of second messengers and ion channels, and influence of neurohormones. We are interested in studies that relate events at the different levels of organization which are involved in regulating the state of responsiveness of the intact organism.

Air Force operations may result in the release of physical and chemical agents that may be harmful to Air Force personnel and the environment. The objective of research in bioenvironmental hazards is to obtain data on the biological effects of exposure to electromagnetic radiations from pulsed and continuous wave sources and to clarify how Air Force relevant chemicals produce their toxic effects.

Research in biocybernetics and workload is oriented toward studying the stages of information processing and allocation of attention during work. Emphasis is on noninvasive techniques for monitoring neural activity during performance of sensory, cognitive, and motor tasks.

Information processing covers research on the adaptive networks in biological systems and machine systems and the human sensory-motor processes. The goals are to explain the neuronal mechanisms that underlie goal-directed behavior, pattern recognition, learning, and associative memory; to stimulate new approaches to the design of adaptive networks for intelligent machines; and to quantitatively describe those aspects of sensory-motor processing that are most relevant to aircrew performance, selection, and training; to rapid and accurate interpretation of computer-generated information; and to the development of robotic systems.

199. TITLE: Research in Mathematics of Control and Dynamics for Aerospace Systems

DESCRIPTION: Basic research in mathematics covers the mathematics of dynamics and control, computer science, computational mathematics, physical mathematics, probability and statistics, and system science. Research in the mathematics of dynamics and control includes robust control, adaptive control, stability theory, optimal control stochastic control, filtering, nonlinear control, and identification and optimization of lumped and distributed parameter systems. Research in computer science focuses on distributed and parallel processing, programming theory, artificial intelligence, and data management systems. Research in computational mathematics seeks to develop algorithms that can be coded reliably, efficiently, robustly, or automatically for serial, vector, and parallel computers with emphasis on ways to numerically solve partial differential equations and algebraic equations. Research in physical mathematics examines new analytical models and methods for solving physical and applied mathematical problems in aerodynamics, aeroelasticity, and electromagnetic theory. Research in probability and statistics addresses new methods and the expansion and generalization of existing methods in probability theory, statistics, stochastic processes, statistical communications theory, and reliability for real systems. Research in system science includes optimal filtering, signal processing, information theory, applied analysis, finite mathematics, optimization, and graph theory in network analysis.

200. TITLE: Research on Physical Processes of Plasmas, Lasers, Microwave Devices, Space Prime Power, and Directed Energy Concepts

DESCRIPTION: This project supports research in optical physics, pulsed power, atomic and molecular physics, particle beam technology, and the physics of collective phenomena. Optical physics addresses research in the vacuum ultra-light to the near millimeter range of the spectrum. Emphasis is on coherent light and its interactions with matter. Pulsed-power investigations center on electron-beam, laser-triggered, and sustained switching, the spectroscopy of switch plasmas, an understanding of high power repetitive opening switches, and an understanding of the ways switch electrodes and insulators break down and erode. Research in atomic and molecular physics concerns the properties and interactions of atoms and molecules. Research in particle beam physics includes investigations of intense, high energy, charged and neutral beams and studies of negative ion sources. Studies of the physics of collective phenomena examine the collective effects of low temperatures and the physical processes associated with producing radiation at X-ray, soft X-ray, millimeter wave, and microwave frequencies.

201. TITLE: Study Near-Earth Space Conditions to Prevent Degradation of Military Systems Operating in Space

DESCRIPTION: Space environmental conditions produced by radiation and atomic particles can endanger the mission and degrade the performance of military spacecraft, disrupt the detection and tracking of missiles and satellites, distort communications, and interfere with surveillance operations. The objective of research in this project is to study the particles, electric and magnetic fields, and radiation that affect the environment of near-earth space. Studies should be designed to examine the following topics: Ways to specify and forecast solar wind and magnetospheric conditions with ground-based measurements, such as radio star scintillations and geomagnetic pulsations; celestial background radiation; ways to improve the resolution of space object images; distribution of plasma and magnetic fields within the magnetosphere; and the earth's radiation belts and their responses to natural and artificial disturbances.

202. TITLE: Improve the Accuracy of Locating Geographical Positions and Establish Methods to Reliably Differentiate Between Earthquakes and Underground Detonations

DESCRIPTION: The research in this project is stimulated by the need to guide and control missile systems, conduct advanced tests of components, site silos, discriminate among the sources of nuclear explosions, and conduct reconnaissance and surveillance missions. The scientific disciplines involved are geodesy, gravity, geology, and seismology. Research in geodesy defines the exact position of targets with respect to missile launch sites. Research in gravity examines the effect of gravity on missile guidance systems along flight paths. Research in seismology studies the effects of earthquakes, nuclear explosions, and other natural or system-generated noise on the degradation of missile guidance systems before launch.

203. TITLE: Advanced Physiological Measures to Predict Performance Decrement

DESCRIPTION: There is increasing need to develop extremely sensitive predictors of impending decrements in operational performance before they would have an opportunity to impact a mission. While some behavioral measure of performance would do this, few of these are non-intrusive, or are easily implemented in real-world settings. Yet, as systems become more complex and less forgiving, and as they depend more on cognitive abilities, the need for early warning and prediction becomes critical. Physiological metrics such as the cortical evoked response, the magnetoencephalogram, and other sensitive procedures show some promise of providing the desired non-intrusive, sensitive metrics. The realization of these possibilities, however, will require considerable innovative work in terms of hardware design and miniaturization, as well as, artifact rejection and other significant advances in data analysis software. In addition, validity, reliability, and field acceptance of such procedures must be defined. For any creative solution to these problems, initial efforts to define the feasibility and specific implementation plan are required. This effort should not be limited to the above mentioned techniques, but should consider any physiological procedure which satisfies the criteria of potential validity, field usability, and predictive sensitivity.

204. TITLE: Human Factors Engineering (HFE) Performance Measurement, Test and Evaluation

DESCRIPTION: Information is sought concerning techniques and methodologies of testing and evaluating the total HFE design of major weapon systems, and command, control, and communications centers. Although the adequacy of specific hardware may be evaluated in a reasonably straight forward manner by reference to applicable human engineering design standards, the adequacy of the man-machine combination in the total systems context is a more difficult determination. Meaningful performance test/evaluation criteria and requirements must be established well before the formal test and evaluation stage of system acquisition. Novel approaches are sought in predicting, observing, quantifying and relating human performance in the operational environment to total mission and system effectiveness. Research is needed to develop techniques or methodologies that can assist in answering these questions: (1) Will the new equipment and software actually improve operator performance under specific conditions; and (2) If the capability is targeted at improving one function within an operational situation, what will be the impacts on associated functions with the operation? Products may include measures of effectiveness that planners and developers can use to evaluate alternative concepts before decisions are made to build the capability into hardware and software.

205. TITLE: Expert System Tools for Job Aiding

DESCRIPTION: With the move away from intermediate maintenance and austere basing concepts, the "remove and replace" philosophy will place an intolerable burden on the logistics pipeline. Consequently, flexible new tools for job aiding must be developed for allowing more efficient maintenance. Expert systems technology offers one solution for solving this problem. Software tools that emulate the capabilities of a senior technician for completing complex maintenance tasks are needed, and exploratory development is necessary in knowledge representation, troubleshooting techniques, and expert system software.

206. TITLE: Display for Low Level Terrain Following Flight

DESCRIPTION: This project consists of improving the display format(s) used by aircrews when performing terrain following (TF) flight. No systematic engineering approach has been utilized to test candidate display formats. Human factors considerations were not adequately assessed in development of the TF display formats currently in use, thus the formats do not effectively present the required information to insure mission demanded (200-500 feet above ground) pilot performance when flying manual TF. Purpose of this project is to take such factors as aircraft performance, available avionics processing capability, current display technology, and human information processing and tracking capability into consideration; then test out candidate format designs.

207. TITLE: Development of Radiofrequency Radiation Detection Systems

DESCRIPTION: The U.S. Air Force operates many radiofrequency radiation (RFR) emitters. Thus, a relatively large work force (about 100,000) is exposed to some level of RFR on a daily basis. Hand-held radiation monitors are available

to measure RFR levels from about 0.1 - 100 mW/cm<sup>2</sup>, but there are no devices available that can measure personnel exposures at lower RFR intensities over any reasonable time period.

Some form of integrating personnel dosimeter is desired for quantifying RFR exposures in the Air Force workplaces. Both a wearable device and a device that could be fixed at a regular work station (such as avionics repair and maintenance shops) are needed. It is desirable that it be able to measure periodic exposures to RFR levels from 0.001 to 1 mW/cm<sup>2</sup>.

208. TITLE: Development of Hand-Held Integrating Dosimeter

DESCRIPTION: Develop a prototype (hand held) electronically integrating radiation dosimeter using solid state detectors capable of detecting electrons (betas), protons, alpha particles, X and gamma rays. System should have digital readout in millirad from 00001 to 99,999 millirad. System should be capable of accurate operation in fields from 5 mrad/day to 100 rad/hr. System must be rugged enough for use in STS and aircraft. Special Modification - Solid State detector system for detection of fast neutron radiation fields.

Applications - (1) On board radiation monitor for spacecraft, (2) Fall-out radiation monitoring, (3) Monitoring of albedo neutron radiation in LEO missions and high altitude aircraft flights, (4) Radiation monitoring in power reactor environments.

209. TITLE: Improved Neck for Ejection System Testing Manikins

DESCRIPTION: The neck structures of ejection system and crash/impact test manikins have limited human-like biofidelity in their response to vertically and horizontally applied accelerations. Increasing interest in the effects of stresses in and transmitted through the neck due to the encumbering of the head with various life-support, protective and performance-enhancing equipment has resulted in a requirement for the development of an improved mechanical neck structure. This structure must provide proper human-like, three-dimensional kinematics of the head for horizontally and vertically applied accelerations; possess provisions for readily modifying internal resistance to flexation; have integrated, multi-axis force transducers for measurement of transmitted forces; and be designed to be compatible with current state-of-the-art testing manikins. Initial emphasis is on design concepts, methods of mechanical implementation and demonstration of the feasibility of the approach. The program is expected to lead to prototype fabrication; testing for response and compliance with overall testing manikin requirements; and a final refined design suitable for multiproduction purposes.

210. TITLE: Heating Rate Effects on Thermal and Mechanical Properties of Phenolics

DESCRIPTION: Phenolic materials are used in solid rocket motor nozzles as insulators. Thermal stresses, therefore, arise due to expansion of these materials. Research is needed to better understand the relationship between rate of heating and thermal/mechanical properties of carbon and silica phenolics. Of particular concern is the effect of heating rate on the cross-ply coefficient of thermal expansion.

The objective of this project is to define and verify test techniques which will yield reliable values for thermal and mechanical properties of phenolics under various heating rates. The ultimate goal would be to develop a data base for phenolics under various heating rates and temperatures.

211. TITLE: Internal Inspection of Long Tubes

DESCRIPTION: The 1000 ft track of Range G must be inspected prior to each firing to insure that there is no damage to the track surface, and that no foreign objects protrude into the model path. At the present, this task is accomplished manually which requires approximately four hours to complete. It is desired to develop a device that would accomplish this task and reduce the time required. The device must locate and remove foreign objects. The track has a 7 inch outside diameter with four rails protruding inwards to provide a 2.5 inch diameter track. It is further required that the device be adaptable to a 2.5 inch inside diameter tube 500 ft in length.

212. TITLE: Continuous Wave Radar for Range Track G

DESCRIPTION: It is desired to fabricate and evaluate a phase coherent, bistatic, dual receiver, continuous wave (cw) superheterodyne radar system for use in the Range Track G. The radar should operate at a transmission frequency of 70 GHz. Solid-state, frequency stabilized microwave sources and associated phase-locking techniques should be investigated in attempting to fabricate a state-of-the-art cw radar capable of a sensitivity of the order of 90 dbm.

213. TITLE: Determination of Installed Thermocouple Response

DESCRIPTION: Turbine engine test requirements include numerous temperature measurements of the facility and engine. Most of these temperature measurements are made using conventional thermocouples (T/C's) installed in direct contact with the test specimen and are not readily accessible. A technique is needed to determine the frequency response of these installations. A potential technique (Seebeck Effect) involves using small electrical currents to heat or cool the T/C junction and observing the return-to-ambient rates. Requirements of such a technique include: (1) compatible with T/C types IC, CA, and CC, (2) operate with T/C lead resistances up to 40 ohms, (3) accommodate thermocouple wire sized from No 36 to No 18, and (4) use non-lethal voltages.

214. TITLE: Combustor Exit Temperature Measurement

DESCRIPTION: The current generation of gas turbine engines operate at combustor exit gas temperature levels higher than the reliable operating range of existing gas temperature measurement systems used for engine development testing. As a result, combustor exit gas temperature is generally calculated based on work balance or combustion efficiency assumption. Accurate measurement of combustor exit gas temperature in conjunction with other measurements would allow a more reliable determination of both combustion and turbine efficiency. A gas temperature measurement system capable of reliable operations in an engine/test cell environment covering the range of approximately 2,000°F to 3,200°F with a measurement uncertainty of  $\pm 15^\circ\text{F}$  is needed.

215. TITLE: Automatic Clearance Control Labrinth Seal

DESCRIPTION: Measurement of aircraft propulsion engine thrusts during operation at altitude flight conditions normally requires use of a pressure-balanced labyrinth-type seal to isolate the engine from the test cell ground plane. The engine mounting system, thermal growth, and other installation characteristics can require more than otherwise desirable seal radial clearance. A reliable method of sensing seal radial clearance and remotely adjusting the lab seal system to provide automatic seal-to-duct clearance control is needed. Radial positioning of the lab seal to within  $\pm 0.010$  of the desired setting is required.

216. TITLE: Robotics for Rapid Runway Repair (RRR)

DESCRIPTION: Repairs to airfield pavements following a non-nuclear attack must be made rapidly and under extremely hazardous conditions. Numerous bomblets capable of throwing hundreds of lethal fragments several hundred feet as well as other types of unexploded ordnance will probably be scattered throughout the area. They may be in the craters themselves, in scabs in the pavement, or mixed with the debris surrounding the craters. Others may be in the grass adjacent to the pavement. The bomblets may include both antipersonnel and antivehicle types with various fuzing mechanisms including simple time-delay and antidisturbance fuses. While an attempt will be made to clear these bomblets prior to starting pavement repairs, many will remain. Personnel and equipment casualties are likely, especially during the initial phases of the repairs. One approach to reducing the personnel casualties is to perform the initial repair tasks with unmanned equipment. Research should identify the most promising robotic equipment as well as the best concept for operations (remotely controlled with appropriate feedback systems, computer controlled with preprogrammed tasks, or some combination). Research should also identify pertinent trade-offs, such as: survivability, time to perform the repair tasks, cost, flexibility, etc.

217. TITLE: Modeling of Reinforced Concrete Using the Discrete Element Method (DEM)

DESCRIPTION: A requirement exists to develop an analytical model to predict spall and cracking of reinforced concrete subjected to conventional weapons effects. Current models use the Finite Element Method (FEM) which allows

deformations, but not break-up of the structure. The Discrete Element Method (DEM) allows the structure to separate and split into individual elements acting as rigid bodies which is more realistic in a high dynamic loading environment. The DEM technique offers a technological opportunity to accurately model reinforced concrete spall and cracking behavior subjected to high dynamic loading and strain rates. The effort will include state-of-the-art assessment of applicable analytical models and supporting mathematical techniques, developing the DEM analytical model, and experimentation to validate the DEM technique and fully develop the DEM as an analysis tool.

218. TITLE: Feasibility of Modeling Fire Suppression

DESCRIPTION: A requirement exists to devise a technique for scaling the required quantities of fire suppressants from small aircraft to large aircraft fires. The required quantities of specific suppression agents can only be determined for large three dimensional aircraft fires by costly testing. Cost effective experiments can be done on small fires but the means to translate small-scale results to large-scale performance does not exist. This is because of the lack of a practically correct and readily application techniques to scale fire behavior.



Topics #175-180

ESD/XRCT  
MITRE D Building, Room 1D227  
(Attn: Maj Stegmaier)  
Hanscom AFB MA 01731

Topics #181-190

AD/PMR  
Building 350, Room 428  
Eglin AFB FL 32542

Topics #191-202

AFOSR/XOT  
Building 410, Room A113  
Bolling AFB DC 20332

Topics #203-209

HQ Aerospace Medical Division  
AMD/RDO  
Directorate of Resources and Operations  
Building 150, Room 224  
Brooks AFB TX 78235

Topic #210

AFRPL/TSPR  
Building 8353, Room 115  
Edwards AFB CA 93523

Topics #211-215

AEDC/DOT  
Building 900, Mail Stop 900  
Arnold AFB TN 37389

Topics #216-218

HQ AFESC/RDXP  
Building 1120  
Tyndall AFB FL 32403

DEFENSE ADVANCED RESEARCH PROJECTS AGENCY

Submitting Proposals

The responsibility for carrying out the DARPA SBIR Program is vested in the Program Management Office. The DARPA Coordinator and Manager of the program is Dr. John K. Meson.

DARPA invites the small business community to send proposals directly to DARPA under the following address:

Defense Advanced Research Projects Agency  
Program Management Office  
ATTN: Dr. John K. Meson  
1400 Wilson Boulevard  
Arlington, VA 22209

The proposals will be processed in the Program Management Office and distributed to appropriate technical offices for evaluation and action.

DARPA identified 17 technical topics to which the small business can respond. A brief description of each topic is included below.

## 1. High Resolution Semiconductor Analytical Techniques

Compound semiconductors, such as the GaAs-based III-V alloys, and HgCdTe, potentially will have widespread use in DoD systems. Rapid, high spatial resolution ( $\sim 1$  MICRON) instruments are needed for materials development and quality control proposed if these materials systems are to be developed to maturity suitable for manufacturing purposes. Proposed concepts/approaches should have one or more of the following potential capabilities: (1) Measure lateral alloy uniformity to  $\pm 0.002$  mole fraction with a lateral spatial resolution  $\sim 1$  MICRON  $\times$  1 MICRON and depth resolution  $\sim 200 \text{ \AA}$ ; (2) Alloy composition vs. depth to  $\pm 0.002$  mole fraction with depth resolution  $\sim 50 \text{ \AA}$  and lateral resolution  $\sim 50$  MICRON  $\times$  50 MICRON; (3) Minority carrier properties (e.g. lifetime and mobility) with spatial resolution similar to those stated in (1) and (2) above. The Proposed techniques should be compatible with commercialization (e.g., not dependent on a fixed major facility), and incorporation and use in an electronics manufacturing environment.

New Microscale characterization techniques which may not meet the spatial resolution goals described above, but would provide novel and unique insight into the nature and properties of compound semiconductor structures, also will be considered. First priority, however, will be given to new techniques which do offer the potential to meet the spatial resolution goals.

## 2. Military Applications of Conducting Polymers

In the later 1970's, the materials field of conducting and semiconducting organic polymers was opened with discovery of the Prototype material, doped polyacetylene,  $(\text{CH})_x$ . In broad terms these materials have conceptual applications as classical semiconductor device structures, lightweight wires, electro-magnetic shielding, transparent conducting coatings, batteries, and perhaps optical fibers. While the stability and other Properties of  $(\text{CH})_x$  initially precluded "real world" use of conducting  $(\text{CH})_x$  in these applications, subsequent development of other much more robust<sup>x</sup> conducting polymers (as well as advances in  $(\text{CH})_x$  itself) suggest that these materials now deserve detailed considerations for applications to military systems and problems. This task seeks to identify and develop specific concepts for the application of conducting polymers in military systems. Proposals must elucidate clearly and concisely the potential advantages of using conducting polymer materials compared to any presently used material, and/or elucidate a unique system capability which will result. Polymers which exhibit electronic or ionic conduction are of interest. Proposals which comprise largely of research and characterization of potential new conducting polymer systems will not be considered in this task.

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### 3. Electro-Optic Techniques for VLSI Interconnect

A major limitation to achieving significant speed increases in VLSI lies in the metallic interconnects. They are costly not only from the charge transport standpoint but also from capacitive loading effects. The Department of Defense, in pursuit of the fifth generation supercomputer, will be investigating alternatives to the VLSI metallic interconnects, especially the use of optical techniques to transport the information either inter- or intrachip. Interests include such areas as source and detector integration onto a VLSI chip, the optical control of integrated electronic devices, optical switching elements, reconfigurable optical channels, and all-optical generalized cross-bar switching networks.

Guided channels may be considered for intrachip interconnects, but the advantages of unguided optical channels should play a major role in solving interchip and interprocessor communications. Once the electronic signals have been converted to optical signals, optical imaging and holography may be used to guide the optical beam to its destination which would likely be a photo-detector to another chip. One may go so far as to envision reprogrammable interconnects employing the optical phenomena of four-wave mixing. The bottom line in realizing opto-electronic interconnects is a need for research into nonlinear optics because it is the nonlinear aspect of optics that lies at the root of many of the desired operations-- from integrated light sources, through optical switched and reconfigurable channels, to four-wave mixing. Consideration will be given to proposed studies into nonlinear optical materials, new device concepts, optical/electronic integration schemes, and interconnect architecture.

### 4. Lightweight Robot Manipulator Technologies

There is a need for robotic arms and end effectors which are lightweight, fast and accurate. This new generation of robots will probably be constructed from carbon-reinforced epoxy, metal matrix composites, or non-rigid metallic frame. Target performance characteristics are as follows: accuracy  $\pm 200$  micrometers; speed - 3 to 5 meters per second; and carrying capacity- 100 kilograms. Other desirable innovations include non-linkage design with continuous degrees of freedom and lightweight direct drive actuators with distributed power.

## 5. Single Mode Fiber Optic Switch

Unattended fiber optic telemetry systems have stringent requirements for long term reliability. One way of enhancing system reliability is to allow the use of alternate optical paths in the event of electronics failure. Redundant optical paths are now implemented by using optical couplers, which permanently split the optical paths and energy. An alternate method would be through the use of an optical switch or commutator, in which the optical path is physically changed by a mechanical means. Mechanical switches are made more difficult by the shift of the fiber optic telemetry implementation to single mode optics with light core diameters of 5 microns. The resulting tolerances for a match between optical waveguides are one micron or less.

The objective of this effort is to develop and demonstrate a single mode fiber optic commutator, or multiple pole switch. A six pole, two to six position commutator which will switch a single mode (1.3 micron wavelength color) network between two to six configurations is desired, but there would be use for a single pole dual throw optical switch.

The switch would be required to operate only infrequently (hours to years between operations) and for a limited number of times (greater than ten, less than ten thousand). The switch/commutator must be low power in switching and completely passive while maintaining position. The switch/commutator should be rugged enough to survive military deployment. The switch must be able to be deployed in one position, lay passive for years, then reliably switch on command. In performing the switching operation, the switch/commutator should not require an extensive control network.

The offeror should demonstrate his innovative concept through design and a limited demonstration.

## 6. VLF Sources

High output, non-explosive, broadband acoustic sources are required to implement proposed active surveillance systems' concepts. Operational constraints dictate systems that are simple, reliable and easy to handle at sea. Source levels from 190 dB to 230 dB re micropascal/Hz are needed over the frequency range 5-40 Hz.

#### 7. Expendable String of Fiber Optic Sensors

Develop an inexpensive, thin diameter, low power, passive fiber optical acoustic sensor string which could be deployed in a number of configurations. The need is for a throw-away, all-glass sensor string which could be attached to a weapon body or other device. This body would contain the necessary electronics and signal conditioning equipment. Applications such as mines require long operation on battery power, thus the device should consume low levels of power. The device should be small to allow packaging and deployment in cannisters. The sensors should be capable of operation at deep ocean depths.

Offerors should include a description of the sensor physical configuration, modulation techniques, sampling rates, sensitivity, and dynamic range.

#### 8. Arctic Communications Techniques

With increased activity in Arctic regions, communication systems will be needed to gather information from sensors and data buoys deployed above 70 degrees North. Communication concepts and techniques not based on satellite relay are needed for low to medium data rates (300-2,400 baud). Further, a two way link (simplex) is required to allow control of remote sensors from CONUS sites. Emphasis should be on simple, reliable, and power efficient systems for the remote sensor end.

#### 9. Remote Sensing of Sea Ice Thickness

The thickness of sea ice affects a wide variety of Arctic activities from ice breaker operations to the delivery of weapons through the Arctic ice cap. A reliable means is needed for estimating sea ice thickness from remote sensing platforms such as aircraft, satellites and data buoys. Concepts and techniques proposed must provide for wide area coverage with frequent sampling at resolutions appropriate to missions.

#### 10. Ice Penetration Techniques

In the higher latitudes, particularly above 75° N, it often will be necessary to penetrate sea ice when deploying sensors and/or weapons. Sea ice varies in thickness and strength as a function of age. First year ice ranges 30 cm. to 5 m. thick while multiyear ice will be from 3-4 meters thick. The picture is further complicated by the presence of keels (bottom side) and ridges (top side) caused by the interaction of ice flows in motion.

Practical techniques are needed for delivery of weapons and sensors through the ice from both below and above the ice cover. Rapid deployment (seconds) is important in some instances but in many cases slower penetration (hours) is acceptable. The concepts and techniques proposed should address the full range of environmental and operational requirements.

#### 11. High Power Density Electro-Chemical Energy Sources

Many military systems would benefit greatly from electro-chemical power sources that are well beyond the present state-of-the-art in power density and that have one or more other unique properties; e.g., minimal volume or weight and/or conformability. Examples include man portable systems, undersea vehicles and space systems. While the theoretical bounds on power density are well defined by thermodynamic and physical properties, the degree to which one can approach the theoretical bounds is determined by constraints imposed by electrodes and packaging ("container") materials and design. This task seeks innovative concepts for materials and package design which will make possible a substantial advance in the power density of fieldable electro-chemical power sources. Here an electro-chemical power source can mean a battery or a fuel cell; also, both primary and secondary power sources are of interest. The ultimate goal is a power density of 400 watts/kg in a fully packaged power source. While the task goal is stated in terms of power density (watts/kg), concepts which might lead to other unique attributes (watts/cm<sup>3</sup>, conformability, etc.) or unique combination of such properties also will be considered.

#### 12. High Power Density Components For Electromagnetic Launchers

Electromagnetic launchers are being considered for a variety of missions including anti aircraft, armor and ballistic missile defense. Innovative concepts are needed in a variety of technologies relating to the repetitive operation of such devices as practical weapon systems. High current opening switches and acceleration concepts that mitigate or eliminate opening switches are needed. High power density electrical power supplies and pulse forming networks are desired to minimize the total system weight. Techniques for reducing and rejecting the waste heat generated in switches, rails, inductors and other components are desired for both ground and space based systems. Materials and methods for reducing erosion and increasing life of rails and sliding electrical contacts would be valuable.

#### 13. Development of Surface Current Measurement Probes for Detection of Electromagnetic Field-Induced Body Resonances

Present measuring techniques for electromagnetic field-induced currents on conducting bodies are sensitive to all of the natural resonances of the body. It is known that these body resonances divide naturally into two parts, one set being due to "electric" modes on the body, and the other to "magnetic" modes. A surface charge probe is sensitive to only the electric modes and hence will only be able to detect half of the body resonances. To date, there has been no attempt to construct a dual sensor which will be sensitive to only the magnetic modes. This effort will undertake the design of such a mode sensor and its testing in a laboratory setting.

#### 14. Two-Dimensional Electro-Magnetic Scattering Analysis

An important problem in Radar Cross Section (RCS) analysis is the scattering from an infinite cylinder of arbitrary cross-sectional shape and material composition. Numerical techniques suitable for predicting the RCS at resonant frequencies and above are desired. Such codes should be capable of treating inhomogeneous media (real and imaginary parts of the permittivity and permeability being functions of position). Ideally the technique would successfully analyze sharp spatial discontinuities in material parameters (such as thin resistive sheets) and anisotropies.

#### 15. Molecular Electrical Devices

Existing approaches to the development of very high density submicron electronic and electromechanical devices and circuits rely primarily on the refinement of standard lithographic processes. Such techniques appear to place the minimum features that can be reliably mass produced at between .3 to 1.0 micron. Researchers in biotechnology are developing fabrication techniques that may result in the capability to fabricate features below 0.1 micron. Such concepts include self-ordering molecular films and arrays, biochemical deposition and delineation, and the use of large molecules as circuit elements. This task would result in a survey of such emerging capabilities, identification of centers of excellence, and the development of a research plan that addresses the technical barriers involved in achieving useful devices. The study should include the following specific efforts: as assessment of the ultimate stability of molecular devices; conceptual designs for electrical interconnection to submicron and molecular devices; analysis of thermal dissipation; conceptual designs for the equivalent to the transistor, diode and other electrical components; a survey of potential applications other than electronic circuit elements.

#### 16. Executive Interfaces for Advanced Workstations on a Local Area Network Connected to the ARPAnet

Develop prototype integrated executive interface to the services available on advanced workstations on a local area network connected to the ARPAnet. The interfaces should be visually oriented and require no significant user training for the effective use. The services should include electronic mail, text preparation with integrated graphics, project planning aids, calendars, spreadsheets, databases, and the like. The user interfaces screen bitmap graphics in a Berkley UNIX 4.2 distributed system environment. The deliverable should represent a significant advance beyond commercial products currently available in the market place.



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DEFENSE SMALL BUSINESS INNOVATION RESEARCH PROGRAM  
(SBIR) FY 1985(U) DEPARTMENT OF DEFENSE WASHINGTON DC  
31 JAN 85

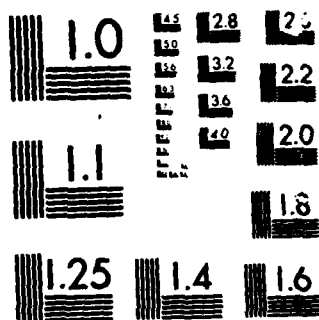
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MICROCOPY RESOLUTION TEST CHART  
NATIONAL BUREAU OF STANDARDS-1062-A

#### 17. Interfacing of Hosts to Networks

Small and inexpensive network interface device: To support a number of networking developments and to make such technology easily usable by the military, there is a need to support the interfacing of hosts to networks and interfacing networks together in a cheap, low power and small size device. With the emerging digital technology, it would seem that this should be possible to do. Cost goals should be \$1000 per unit in production quantities for a device capable of support throughput in the range of 50 kbps and performing functions such as interfacing a local network into the packet switched internetwork system.

SUBMITTING PROPOSALS ON DEFENSE NUCLEAR  
AGENCY TOPICS

The Defense Nuclear Agency is seeking Small Business firms with a strong research and development capability and experience in nuclear weapons effects and nuclear weapons phenomenology areas. Proposals should be submitted to:

Headquarters  
Defense Nuclear Agency  
ATTN: OAAM/SBIR  
Washington, DC 20305

Handcarried proposals should be submitted to:

Headquarters  
Defense Nuclear Agency  
ATTN: OAAM/SBIR  
6801 Telegraph Road  
Alexandria, VA 22310

Questions concerning the research topics should be submitted to:

LtCol Robert Steele  
(202) 325-7300

The research categories proposed for study under this program are:

1. Nuclear Weapons Effects.
2. Nuclear Effects Simulation.
3. Instrumentation.
4. Directed Energy Effects.
5. Nuclear Hardening and Survivability.
6. Security of Nuclear Weapons.
7. Operational Planning.

These topics are further explained below.

Additional information beyond that provided herein may be obtained by request from the address given above.

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1. TITLE: Nuclear Weapon Effects

DESCRIPTION: Exploratory Development: Nuclear weapons effects include air blast, thermal, ground shock, water shock, cratering, personnel, and dynamic loading. Of particular interest is the response of materials, structures, and systems to these nuclear weapons effects. Materials of interest include metals, ceramics and composites. Any new material capable of being used as a structural member is of particular concern for aircraft, missiles, ships (both surface and subsurface) and military vehicles. The response of underground structures, such as missile silos, command and control facilities and communications facilities are especially important. Also of interest are transient and permanent radiation effects on new types of electronics and sensors. Concepts and techniques which will improve the survivability (decrease the response) of systems to these nuclear weapons effects are required.

2. TITLE: Nuclear Effects Simulation

DESCRIPTION: Exploratory Development: International treaties preclude the testing of nuclear weapons in the atmosphere and hence we are unable to test military systems in an actual nuclear environment. To compensate for this, other test techniques are used to simulate the effects of the nuclear detonation. Nuclear weapons effects simulation includes: high explosive testing to simulate the mechanical effects, EMP simulation, thermal radiation simulation, and nuclear radiation simulation. Simulation techniques should be as realistic as possible, relatively inexpensive to perform and comparable to the threat environment. Improvements to nuclear simulations are required to address their possible use in a training and/or operational sense for combat troops. An extensive program currently exists for all areas of simulation and one should become familiar with those to see how they can be improved and/or combined in order to make the total process more realistic and more representative of the actual nuclear weapons effect being studied. Both destructive and non-destructive test methods are desired.

3. TITLE: Instrumentation

DESCRIPTION: Exploratory Development: Instrumentation is used for measuring nuclear weapons effects and phenomenology parameters and the response of test items exposed to these weapons effects. The instrumentation should be capable of operating under very harsh conditions, such as might be encountered in an underground nuclear test, a high explosive test, or test involving high levels of x-ray, gamma, or neutron radiation. The instrumentation should, for the most part, be survivable and include recording, data transmission and data analysis capabilities. Concepts are required for new instrumentation utilizing state of the art technology which will result in improved data collection with better accuracy at lower cost.

4. TITLE: Directed Energy Effects

DESCRIPTION: Research: The effects of directed energy (e.g., lasers) sources on materials, structures and systems are of interest. Of particular interest is the establishment of the correlation between nuclear weapons effects and directed energy effects, the identification of

materials which are capable of withstanding both nuclear weapons effects and directed energy effects, and mechanisms by which the directed energy effects actually interact with target materials/structures.

5. TITLE: Nuclear Hardening and Survivability

DESCRIPTION: Engineering Development: Techniques for nuclear hardening and survivability of systems/structures against nuclear weapons effects and, where compatible, directed energy effects are required. These techniques should protect the structure or system against the combined effects of blast, thermal and nuclear radiation in the cases of structures or materials, and should also provide protection against electromagnetic and radiation effects wherever any electronic capabilities are involved. In particular, the ability to harden communications facilities and surveillance sensors against electromagnetic pulses is required.

6. TITLE: Security of Nuclear Weapons

DESCRIPTION: Exploratory Development: Measures to improve the security of nuclear weapons against all possible threats are required. This includes the design of security features both for the actual weapons and for the facilities in which weapons are either stored or transported. These security measures should protect against all known or predicted threats and should be done in such a way as to avoid making the protected item visible as a target.

7. TITLE: Operational Planning

DESCRIPTION: Research: The nuclear employment planning capabilities of operational commanders in tactical, strategic and integrated warfare environments should be improved. Improvements desired include development of automated planning systems, techniques to determine target damage objective and criteria, post strike target damage assessment capabilities, and automated nuclear weapon employment codes.

**TO: SBIR Proposers**

To prepare better informed proposals addressing any of the topics presented in this DoD SBIR Program solicitation, you may request bibliographies of technical reports produced by prior DoD-funded R&D projects related to appropriate topics; bibliographies will include references to other sources of related information. Additionally, you will receive, if available, information about related DoD-funded R&D projects in progress. You may also request a copy of any of the technical reports you select from the bibliographies.

DTIC authorization to provide this service expires 31 January 1985, the DoD SBIR Program Solicitation 85.1 closing date.

Please use the request form below; fold, staple, stamp and mail it back to us. Type or print legibly complete and accurate information. Be sure to indicate in the space provided that your firm qualifies as discussed in Section 2.0 of this solicitation document.

# SMALL BUSINESS INNOVATION RESEARCH PROGRAM REQUEST FOR DTIC'S SERVICES

REQUESTER NAME/ADDRESS		NAME	TITLE/POSITION
		ORGANIZATION NAME	
ADDRESS			
CITY.	STATE	ZIP CODE	Area Code / - TELEPHONE NUMBER

Please send technical report bibliographies and other information on the following DoD SBIR solicitation R&D topics:

<u>DoD COMPONENT</u>	<u>TOPIC NO.</u>		<u>DoD COMPONENT</u>	<u>TOPIC NO.</u>
		PLEASE TYPE		
		OR PRINT		

Company status: I confirm that the small business concern identified above meets the SBIR qualification criteria presented in Section 2.2 of the DoD SBIR Program Solicitation No. 85.1.

**Signature of Requester**

STAPLE HERE

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RETURN ADDRESS

PLACE  
STAMP  
HERE

Defense Technical Information Center  
ATTN: SBIR  
Cameron Station  
Alexandria, VA 22314

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TO  
(Fill in firm's  
name and mailing  
address)

SUBJECT : SBIR Solicitation No. 85.1  
(Fill in topic Topic No. \_\_\_\_\_  
No.)

This is to notify you that your proposal in response to the subject  
solicitation and topic number has been received by \_\_\_\_\_  
(Fill in name of  
organization to which you will send your proposal.)

\_\_\_\_\_  
(Signature by receiving organization) (Date)

Reference C

**Directory of Small and Disadvantaged Business Utilization (SADBU) Specialists  
Assigned at Defense Contract Administration Services Regions (DCASRs) and  
Defense Contract Administration Services Management Areas (DCASMA)**

**DCASR Boston**

495 Summer Street  
Boston, Massachusetts 02210  
Tel: 617/451-4316  
ATTN: Edward Fitzgerald

**DCASMA Boston**

495 Summer Street  
Boston, Massachusetts 02210  
Tel: 617/451-4316  
ATTN: Tom Sexton

**DCASMA Hartford**

96 Murphy Road  
Hartford, Connecticut 06114  
Tel: 203/244-3336  
ATTN: John Seaver

**DCASMA Syracuse**

100 South Clinton Street  
Syracuse, New York 13260  
Tel: 315/423-5405  
ATTN: Robert Hunter

**DCAS Residency**

1103 Federal Building  
111 West Huron Street  
Buffalo, New York 14202  
Tel: 716/846-4260  
ATTN: Edward Kirchmeyer

**DCASMA Bridgeport**

550 South Main Street  
Stratford, Connecticut 06497  
Tel: 203/579-5554  
ATTN: John Melendez

**DCASR New York**

201 Varick Street  
New York, New York 10014  
Tel: 212/807-3050 or 3051  
ATTN: John Mulreany

**DCASMA New York**

201 Varick Street  
New York, New York 10014  
Tel: 201/807-3314/3315  
ATTN: Gwendolyn  
Bennett-Clarke

**DCASMA Garden City**

605 Stewart Avenue  
Garden City, Long Island  
New York 11533  
Tel: 516/228-5723 or 5724  
ATTN: Anthony Miele

**DCASMA Springfield**

240 Route 22  
Springfield, New Jersey 07081  
Tel: 201/379-7950,  
x401 or 402  
ATTN: Charles Ferraro

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**DCASR Philadelphia**

2800 South 20th Street  
Philadelphia, Pennsylvania  
19101  
Tel: 215/952-4006 or 4007  
ATTN: Roger Rhyner

**DCASMA Pittsburgh**

1626 Wm. S. Moorhead  
Federal Building  
1000 Liberty Avenue  
Pittsburgh, Pennsylvania 15222  
Tel: 412/644-5943  
ATTN: Kathryn Gabin

**DCASMA, Reading:**

45 South Front Street  
Reading, Pennsylvania  
19602  
Tel: 215/320-5012  
ATTN: Thomas Knudsen

**DCASMA Baltimore:**

300 East Joppa Road  
Towson, Maryland 21204  
Tel: 301/321-4884  
ATTN: Charles Hodson

**DCASR Dallas**

500 South Ervay Street  
Dallas, Texas 75201  
Tel: 214/670-9205  
ATTN: Ken Strack

**DCASMA Phoenix**

3800 N. Central Avenue  
Phoenix, Arizona 85012  
Tel: 602/261-4467  
ATTN: Rosalee Kalwara

**DCASR Chicago**

O'Hare Int'l Airport  
P. O. Box 66475  
Chicago, Illinois 60666  
Tel: 312/694-3031, x6390  
ATTN: James Kleckner

**DCASMA Indianapolis**

Finance Center, U.S. Army  
Building 1  
Ft. Benjamin Harrison,  
Indiana 46249  
Tel: 317/542-3155  
ATTN: Charles Loch

**DCASMA Milwaukee**

744 North 4th Street  
Milwaukee, Wisconsin 53203  
Tel: 414/272-8180, x207  
ATTN: Edward Kaczmarek

**DCASR Cleveland**

AJC, Federal Office Building  
1240 East Ninth Street  
Cleveland, Ohio 44199  
Tel: 216/522-5122  
ATTN: Wilma Combs

**DCASMA Cleveland**

AJC Federal Office Building  
1240 East Ninth Street  
Cleveland, Ohio 44199  
Tel: 216/522-5446  
ATTN: William Fischbach

**DCASMA Dayton**

1507 Wilmington Pike,  
Building No. 1  
Dayton, Ohio 45444  
Tel: 513/296-5150  
ATTN: Betty Adams

**DCASMA Detroit**

McNamara Office Building  
477 Michigan Avenue  
Detroit, Michigan 48226  
Tel: 313/226-5180  
ATTN: Douglas Koster

**DCASMA Grand Rapids**

Riverview Center Building  
678 Front Street, N. W.  
Grand Rapids, Michigan 45904  
Tel: 616/456-2620  
ATTN: Loretta Bumstead

**DCASR St. Louis**

1136 Washington Avenue  
St. Louis, Missouri 63101  
Tel: 314/263-6617  
ATTN: Thomas Moore

**DCASMA St. Louis**

1136 Washington Avenue  
St. Louis, Missouri  
Tel: 314/263-6644  
ATTN: Charles Sackman

**DCASMA Cedar Rapids**

4333 Edgewood Road, N. E.  
Cedar Rapids, Iowa 52402  
Tel: 319/395-0190 Ext 27  
ATTN: Wallace Perkins

**DCASMA Twin Cities**  
2305 Ford Parkway  
St. Paul, Minnesota 55116  
Tel: 612/690-8201  
ATTN: Otto Murray

**DCASMA Wichita**  
Wichita Mid-Continent Airport  
Terminal Building  
Wichita, Kansas 67209  
Tel: 316/943-3263, Ext 19 or 57  
ATTN: George Luckman

**DCASMA Denver**  
701 West Hampden Ave.,  
Suite E3210  
Englewood, Colorado 80154  
Tel: 303/837-5256  
ATTN: Lloyd Johnson

**DCASR Atlanta**  
805 Walker Street  
Marietta, Georgia 30600  
Tel: 404/429-6196  
ATTN: Harold Watson

**DCASMA Birmingham**  
908 South 20th Street  
Birmingham, Alabama 35256  
Tel: 205/254-1460  
ATTN: Lola Alexander

**DCASMA Orlando**  
3555 Maguire Blvd.  
Orlando, Florida 32803  
Tel: 305/896-6113  
ATTN: Russell R Neil

**DCASR Los Angeles**  
11099 South LaCienega Blvd.  
Los Angeles, California 90045  
Tel: 213/643-0620  
ATTN: S.L. Ganalon

**DCASMA San Diego**  
Building 4  
AF Plant No. 19  
4297 Pacific Coast Highway  
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